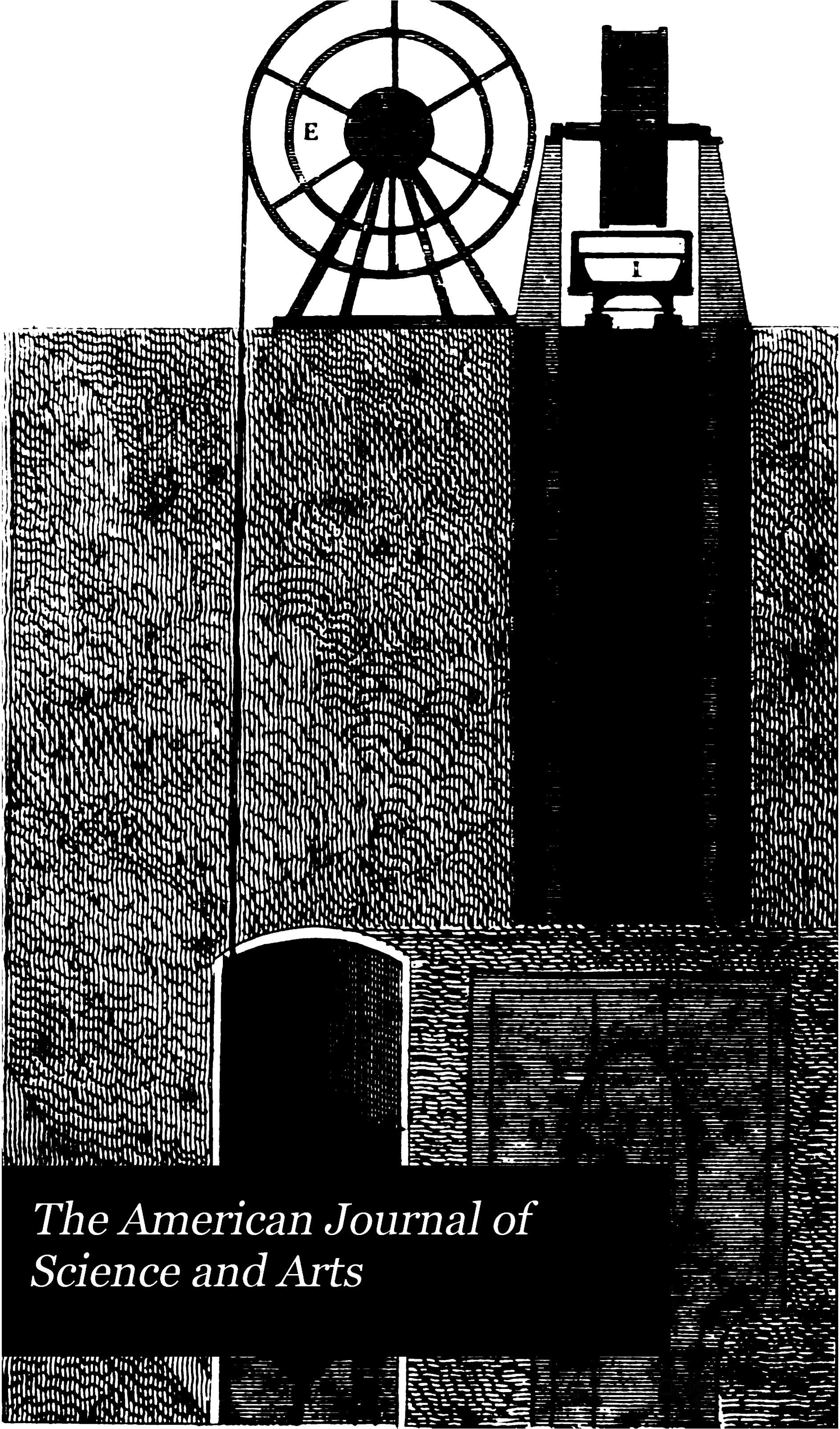
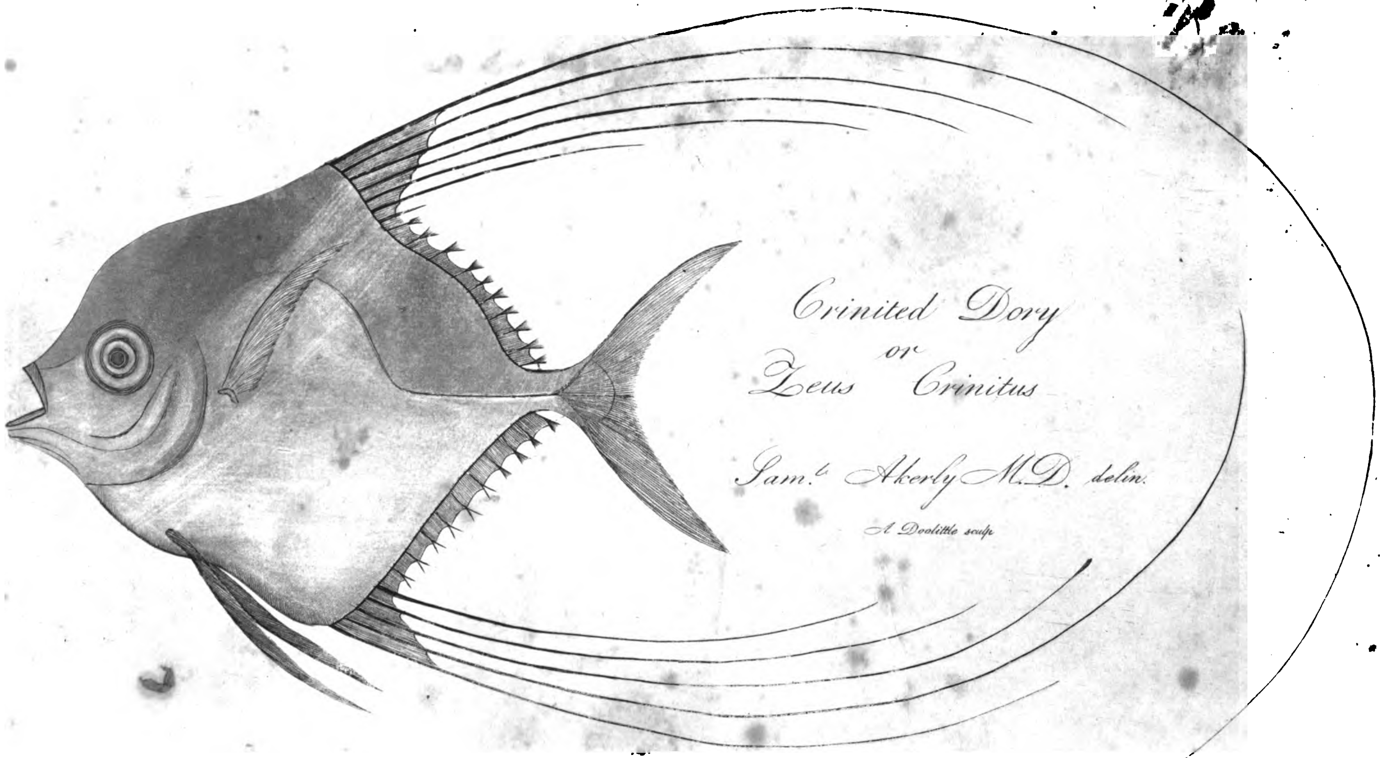


The American Journal of Science and Arts



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THE

AMERICAN JOURNAL

OF

SCIENCE AND ARTS.

CONDUCTED BY

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INTELLIGENCE AND MISCELLANIES.

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INTELLIGENCE AND MISCELLANIES.

THE

AMERICAN

JOURNAL OF SCIENCE, &c.

ART. I.—*Notice of the volcanic character of the Island of Hawaii, in a letter to the Editor, and of various facts connected with late observations of the christian Missionaries in that country, abstracted from a Journal of a Tour around Hawaii, the largest of the Sandwich Islands.*

THE Island of Owyhee, now called Hawaii, has long been famous as the scene of the death of the celebrated English navigator, Captain James Cook.

The atrocity of that scene, although extenuated by some circumstances of provocation, contributed to stamp the character of the natives with the charge of extreme barbarity; a charge which seems, however, to have had no peculiar foundation; the character of the Owyheans appearing to be substantially the same with that of all the inhabitants of the Polynesian groups.

However this fact may have been, an effort was thought worth making to elevate this interesting people to the condition of civilized and christian men. It is well known, that in October 1819, a mission sailed from Boston for the Sandwich Islands, where they arrived in April 1820; and that an additional number of missionaries sailed from New-Haven* in November 1822, and arrived in April 1823.

* Among these Missionaries was Mr. Joseph Goodrich, who, while a member of Yale College, applied himself with diligence to the study of mineral ogy and geology, with particular reference to more extended usefulness as a

Soon after the arrival of this second Missionary family, a tour round the island was resolved upon, with particular reference to the great objects of the mission. Messrs. Ellis,* Harwood, Thurston, Stewart, Bishop, and Goodrich, were charged with the execution of this duty, which they performed with zeal and ability. The result of their observations is detailed in a little volume, ably drawn up by Mr. Ellis, and entitled "a Journal of a tour around Hawaii, the largest of the Sandwich Islands." Besides many interesting statements relative to the paramount objects of the enterprize, it contains a great number more relating to the natural history of the island. From this part of the work, we intend to quote the most important passages, and we conceive that we cannot better introduce them than by the following letter from Mr. Goodrich to the Editor, which, although dated a year ago, has been received only within a few days.

Letter from Mr. Joseph Goodrich, one of the American Missionaries in the Sandwich Islands.

TO PROFESSOR SILLIMAN, NEW-HAVEN, (CT.)

WAIAKEA, (HAWAII,) APRIL 20th, 1825.

MY DEAR SIR,

I confess I have remained silent quite too long, in not answering your kind request on the eve of my embarkation, although I am better able to state facts now than at any former period. The station which I am called to occupy, is on the N. E. side of Hawaii, (pronounced Harwye,) at the head of a safe and commodious harbor, yet but little known to foreigners. About forty miles in the interior, in a south-westerly direction, is a burning volcano, that has been in a state of activity from time immemorial. The oldest natives can give no account of a time when it was not burning: they say it is more active now than it was twelve or fifteen years since.†

Missionary, he having already resolved on devoting himself to that object. Mr. Goodrich made very considerable acquirements in this way; and being endowed with a vigorous frame, and peculiar hardihood and equanimity, he was well qualified for the vicissitudes of a Missionary life in a barbarous country.

The letter annexed, contains so many interesting notices, that I have given it with little abridgement or alteration. Mr. Thurston and Mr. Whitney were also from Yale College, and possessed, in a high degree, the requisite traits of character.

*An English Missionary then on a visit at Hawaii.

† There is now a whaling ship in this port, the Dawn, of New-York, Capt.

On my arrival at these islands, I landed at Oahu, and spent two or three months there. The rocks that I examined there are decidedly volcanic, yet many bear a near resemblance to the trap rock. The soil, in many places, is quite red, and is used by some for red paint; and for any thing that I know, answers every purpose of Spanish brown. The soil is the same on Tuuai, (Atooi.) From what I have seen and heard of all the islands, there is no doubt, in my mind, that they are all volcanic.

The summer after my arrival, I spent about ten weeks in making a tour of this Island, in company with several other members of the Mission family. A journal of that tour will probably be published in America. The Island of Hawaii, from the north point to the southern, including all the west side of the Island, is little else than one entire mass or sheet of lava, which has run down from the mountains at different periods. Some of the currents of lava are so recent, that there is no vegetation to be seen upon them; but others are of a much more ancient date, so that bushes and even trees have sprung up among the beds of lava. Most of the land on the western side of the Island, four or five miles from the shore is high, probably not far from 3000 feet above the level of the sea. In several places, the lava, as it ran down from the mountains, fell over precipices from 20 to 100 feet in height; sometimes presenting the form of stalactites, and at others of stalagmites, and sometimes an entire sheet, like the falling of water over a mill dam, except that the lava was more viscid.

The most remarkable place is eight or ten miles to the south of Kearakekua, which place is to the southward of the middle of the Island. There are four high mountains in the Island, one back of Toaehae, and another back of Kairua, upwards of 7000 feet high, called Hualulae: the two others are vastly higher, namely: Mouna Kea, to the northward

Butler, seven and a half months out, which will probably return about two years hence. Capt. B. expects to come here next fall, and likewise the spring following, on board of whom it is my expectation to put a box of minerals for you, unless I have an opportunity short of that time. I might now send it down to Oahu, the port from which almost all vessels clear out for America. Should I send it down there, it would be uncertain in what vessel they would be shipped, or at what port in America they would arrive. It would then be altogether uncertain whether you would ever receive them. I think it preferable to wait for a good opportunity.

and eastward part of the Island, estimated to be upwards of 18,000 feet high, and Mounà Roa, in the south-western part, probably near the same height. I have been twice to the summit of Mouna Kea. The first time I was at the highest peak about three o'clock at night, in the month of August; the thermometer stood at 27 deg, 5 below the freezing point. I passed over several banks of snow, that lay to the northward of the highest peaks, (this mountain rises much more abruptly than Mouna Roa,) and the change was so great in passing from a torrid to a frigid zone, that I was under the necessity of travelling all the time I was up there to prevent freezing. The second time that I ascended was in April last. There appear to be three or four different regions in passing from the sea shore to the summit. The first occupies five or six miles, where cultivation is carried on, in a degree, and might be to almost any extent; but as yet, not one twentieth part is cultivated. The next is a sandy region, that is impassable, except in a few foot paths. Brakes, a species of fern, here grow to the size of trees; the bodies of some of them are eighteen inches in diameter. The woody region extends between ten and twenty miles in width. The region higher up produces grass, principally of the bent kind. Strawberries, raspberries, as large as butternuts, and whortleberries flourish in this region, and herds of wild cattle are seen grazing. It is entirely broken up by hills and vallies, composed of lava, with a very shallow soil. The upper region is composed of lava in almost every form, from huge rocks to volcanic sand of the coarser kind. Some of the peaks are composed of coarse sand, and others of loose stones and pebbles. I found a few specimens that I should not hesitate to pronounce fragments of granite. I also found fragments of lava, bearing a near resemblance to a geode, filled with green crystals, which I suppose to be augite.

Very near to the summit, upon one of the peaks I found eight or ten dead sheep; they probably fled up there to seek a refuge from the wild dogs; I have heard that there are many wild dogs, sheep and goats. Dogs and goats I have never seen.

I was upon the summit about 2 o'clock P. M., the wind S. W., much resembling the cold blustering winds of March with you, the air being so rare that it produced a severe pain in my head, that left me as I descended. Much more might be said, that I must omit for want of room. The volcano

that I before mentioned is by far the greatest curiosity in the Islands. I presume that it is the largest known; at least it is by far the largest of any of whose dimensions I have seen an account. I have made four visits to the volcano. The last time, I measured the circumference with a line, and found it to be seven and a half miles. Some part of the way I measured within the crater, where the wall was 300 or 400 feet above us. I counted twelve different places where lava was red hot, and three or four where it was spouting up lava thirty or forty feet. The depth of the crater is probably above 1000 feet; down about 500 feet is a black ledge, which appears to have been formed by the crater's being filled up with lava one half way, and the lava being discharged by an outlet under ground. The crater appears to be filling up, for when I was there the last time, I perceived that the lava had run 30 or 40 feet over a place where I crossed the bottom when I was up there about six weeks previous. The lava was then so hot that I could only cross the edges, where it had run out. In the middle of this place it was still spouting out lava. I crossed the bottom in several places that looked quite smooth, as viewed from the top; but on descending I found the surface to be made up of hills and vallies. Dense sulphurous fumes are ascending from almost all parts of the bottom: some of the gaseous substances appeared to smell like muriatic acid gas: the gases are very suffocating, so much so that the crater is impassable in many places. In many places, the escaping of the gaseous substances make a tremendous roaring, like the steam let out of the boiler of a steam engine. On the night of the 22d of December, 1824, a new volcano broke out at the bottom of the large crater; as soon as it was sufficiently light, I descended near to the spot where the lava was both spouting up and boiling like a fountain; some of the lava was thrown forty or fifty feet into the air. It was one of the most awful scenes that I ever witnessed, to see such a mass of lava, red hot, boiling and running like water, although it was not so liquid as water: by sun-rise it had run fifty or sixty rods, and eight or ten rods wide. As I was alone, standing within a few rods of the running lava, I heard a crashing among the rocks of lava behind me. I judged it prudent to retrace my steps. On my visit there six weeks after, I found that it had formed a mound of the lava that had issued out, upwards of sixty feet above the bottom of the crater. The black ledge that I men-

tioned above, extends all round the crater except a few yards; it forms a kind of stair, although it is half a mile wide some part of the way. The crater upon this ledge measures five and a half miles in circumference. Capillary volcanic glass is in great abundance in some places upon the bottom, to the depth of two or three inches; and some is to be seen fifteen or twenty miles from the crater, drifted by the wind and lodged in the crevices of the lava. There are also great quantities of pumice stone about the crater, but so very light and porous, that it is driven about by every puff of wind. It is so delicate in its texture that it is very difficult to preserve the specimens. Fifteen or twenty miles in a southerly direction, the steam and vapours are issuing through almost the whole distance from the cracks and fissures of the lava. The form of the crater is something of the shape of an egg, the longest diameter from N. to S. When one is in the crater, and viewing the rocks below the black body, (which is covered with very porous volcanic glass,) lava of all descriptions may be seen, from that which is loose and porous to that which is very firm and equally compact, as any of the trap rocks. From what I have seen since I have been upon these Islands, I should not hesitate to class lava and trap rocks together; for how can a part of the same mass be in a state of fusion and part not? That which appears to have been under the greatest pressure, is uniformly the most compact. I shall endeavor to send you specimens the first opportunity, although they will not be large, in consequence of having so far to carry them by hand. The land about the crater has fallen in, including a space not much short of six miles in diameter. To the north end of the crater, the land is nearly level for a considerable distance, then it gradually descends to the sea shore: the volcano is probably 8000 or 10,000 feet above the level of the sea: the ground or rocks are also full of cracks and fissures, that render it rather dangerous travelling. When I was up there in December, a native fell through the grass and rubbish into one of the fissures that was concealed, and was drawn up by a rope much bruised.

There are large quantities of sulphur in and about the crater, where, also, whortleberries are growing all the year, but they are not so palatable as those in America; they are about the size of red cherries; the natives do not eat them, considering them sacred to the god of the volcano. There is also a plenty of wild geese, though not so large as tame geese,

The lava in many places is full of the crystals of augite and leucite. The sand upon the sea shore in front my house is composed chiefly of green crystals, which I suppose to be augite. I have tried several specimens of the lava, and find them fusible by the blow pipe. For further information I must refer you to a journal of a tour of this Island that was made the summer after my arrival.

We will now proceed to give, as far as the object in view is concerned, an abstract and analysis of the tour of the missionaries, as drawn up by Mr. Ellis, and although some of the facts are the same as those related by Mr. Goodrich, they are presented in such a connexion, that it will not be unpleasant or unprofitable to have them in part repeated. Mr. Goodrich's letter contains, however, a number of facts not related in the tour. "The tour, says the North American, (for April, 1826,) was begun at Kairua, a village on the western side of the island, and the residence of Kuakini, the principal chief of Hawaii. They proceeded along the coast to the south, east, and north, till they had encompassed the island, having occupied in their rambling, a little more than two months. They made frequent excursions inland, visited the principal villages, conversed with the people, preached to them on proper occasions, and collected such information as in the most satisfactory manner to answer the ends of the mission. A guide was furnished them, called Makoa, a person of a somewhat remarkable appearance and character, to judge from his picture, and the description of him in the book. But he was faithful to his duty, and the travellers were hospitably received, and civilly treated wherever they went."

In the report of the deputation, which is prefixed to the narrative of Mr. Ellis, they remark: "We have been enabled to collect considerable information on a variety of subjects, which, though of secondary moment, in the missionaries' account, are nevertheless interesting and important; such as the natural scenery, productions, geology and curiosities; the traditionary legends, superstitions, manners, customs, &c. "In the prosecution of our design, to *explore* and *enlighten* the long benighted Hawaii, we have ascended its lofty and majestic mountains, entered its dark caverns, crossed its deep ravines, and traversed its immense fields of rugged lava. We have stood with wonder on the edge of its ancient craters, walked tremblingly along the brink of its smoking chasms,

gazed with admiration on its raging fires, and witnessed with no ordinary feelings of awe, the varied and sublime phenomena of volcanic action, in all its imposing magnificence and terrific grandeur."

The Hawaiians, we are assured, like other barbarous nations, are accustomed to recognise "the presence of some unpropitious deity"—"in the sighing of the breeze, the gloom of the night, the boding eclipse, the meteor's glance, the lightning's flash, the thunder's roar, and the earthquake's shock."

They have a goddess of volcanoes, whom they call *Pele*, and "they are continually reminded of her power, by almost every object that meets the eye, from the rude cliffs of lava, against which the billows of the ocean dash, even to the lofty craters, her ancient seat amid perpetual snows."

The volcanic character of Hawaii is highly interesting, and the proofs of this character presented by the missionaries, are so numerous, that they recur almost every where in their progress, and so satisfactory, that their statements cannot fail to produce entire conviction.

In the vicinity of Kairua, they attempted to excavate a well, as there was no good water within five or six miles of the town. In the prosecution of this effort, "they entered several caverns in the lava, resembling an arched vault, or extended tunnel of various thicknesses and dimensions. They supposed the lava at the edges of the torrent had first cooled, hardened, and formed the side walls, which approximated as they rose, until uniting at the top, they became a solid arch, enclosing a stream of lava, which continued to flow on towards the sea. One of these tunnels, called Raniakea, they found to be of considerable extent. After entering it by a small aperture, they passed on, in a direction nearly parallel with the surface, sometimes along a spacious arched way, not less than twenty-five feet high, and twenty wide; at other times by a passage so narrow that they could with difficulty press through, till they had proceeded about 1200 feet. Here their progress was arrested by a pool of water, of considerable extent and depth, and salt as that found in the hollows of the lava, within a few yards of the sea. This latter circumstance, in a great degree damped their hopes of finding fresh water, by digging through the lava. In their descent, they were accompanied by more than thirty natives, most of whom carried torches. On arriving at the water, they simultaneously plunged in, extending their torches with one hand, and swimming about with the oth-

er. "The partially illuminated heads of the natives, splashing about in this subterranean lake, the reflection of the torch light on its agitated surface, the frowning sides and lofty arch of the black vault, hung with lava, that had cooled in every imaginable shape, the deep gloom of the cavern beyond the water, the hollow sound of their footsteps, and the varied reverberations of their voices, produced a singular effect; and it would have required little aid from the fancy, to have imagined a resemblance between this scene and the fabled Stygian lake of the poets." "The mouth of the cave is about half a mile from the sea, and the perpendicular depth to the water, is probably not less than fifty or sixty feet. The pool is occasionally visited by the natives, for the purpose of bathing, as its water is cool and refreshing. From its ebbing and flowing, it has probably a direct communication with the sea." It was ascertained that the point which forms the northern boundary of the bay, and "runs three or four miles into the sea, is composed entirely of lava, and was formed by an eruption from one of the large craters, on the top of Mouna Huararai, about twenty-three years ago, which filled up an extensive bay, twenty miles in length, and formed the present coast. A number of villages, plantations, fish ponds, &c. were at that time destroyed."

It was observed that in several places "the sea rushes with violence along the cavities beneath the lava, to a considerable distance, and then, forcing its waters through the apertures in the surface, forms a number of jets d'eau, which falling again on the rocks, roll rapidly back to the ocean."

In the morning of June 28, 1823, "Messrs. Thurston, Goodrich, and Harwood, walked towards the mountains, to visit the high and cultivated parts of the district. After travelling over the lava for about a mile, the hollows in the rocks began to be filled with a light brown soil; and about half a mile further, the surface was actually covered with a rich mould, formed by decayed vegetation and decomposed lava." The fences were made with the fragments of lava, enclosing small and well cultivated fields, "planted with bananas, sweet potatoes, mountain tard, tapa trees, melons, and sugar cane, flourishing luxuriantly in every direction."

After passing three or four miles, through this "delightful region," they found several pools of fresh water, and arrived at the woody region, which extends several miles up the sides of the lofty mountain, that rises immediately behind Kairua.

This mountain, called Kuararai, is one of the three highest in Hawaii, and it was very natural that the travellers should wish to ascend to its summit. "The varied strongly marked volcanic surface" of the higher parts—"the traditional accounts of its eruptions, the thick woods that skirt its base, and the numerous feathered tribes that inhabit them," all conspired to make it an object of high interest. About 8 o'clock, on the morning of July 9th, they commenced the ascent, accompanied by three native guides. After travelling about 12 miles, they arrived at the last house on the western side of the mountain. Their guides were unwilling to proceed any farther that night, but the missionaries proceeded without them, and "travelled about six miles over a rough and difficult road, sometimes across streams of lava full of fissures and chasms, at other times through thick brush-wood, or high ferns, so closely interwoven as almost to arrest their progress." They passed the night in a temporary hut, erected on the lava, and the morning of the 10th was ushered in by the singing of birds. The thermometer was 46 deg. on the outside of the hut—on the sea shore it is usually about 84 deg. Having united in their morning orisons, they proceeded on their journey; "their road lying through thick underwood and fern, was wet and fatiguing, for about two miles, when they arrived at an ancient stream of lava, about twenty rods wide, running in a direction nearly west. Ascending upon the hardened surface of this stream, over deep chasms, and huge volcanic stones, a distance of three or four miles, they reached the top of one of the ridges, on the western side of the mountain." They met with strawberries which were rather insipid, and with raspberries which were white and large, but not so well flavoured as those of Europe and America.

"Between nine and ten in the forenoon, they arrived at a large extinguished crater, about a mile in circumference, and apparently 400 feet deep. The sides were regularly sloped, and at the bottom was a small mound, with an aperture in its top. By the side of this large crater, divided from it by a narrow ridge of volcanic rocks, was another, fifty-six feet in circumference, from which volumes of sulphurous smoke and vapour continually ascended. No bottom could be seen, and, on throwing stones into it, they were heard to strike against its sides for eight seconds, but not to reach its bottom. There were two other apertures very near this, nine feet in diameter, and apparently about two hundred feet deep. Walking along

its giddy verge, they could distinguish the course of two principal streams, that had issued from it, in the great eruption about the year 1800. One had taken a direction nearly north-east. The other had flowed to the north-west, in broad irresistible torrents, for a distance of from 12 to 15 miles to the sea, and, driving back the waters, had extended the boundaries of the island. The party attempted to descend the great crater, but the steepness of its sides prevented their examining it so fully as they desired. After spending some time there, they walked along the ridge between three and four miles, and examined sixteen different craters, similar in their construction to the first they met with, though generally smaller in their dimensions. The whole ridge appeared little less than an assemblage of craters, which, in different ages, had deluged the vallies below with floods of lava, or showers of burning cinders. Some of them appeared to have reposed a long period, as they were covered with earth and clothed with verdure. Trees of considerable size were growing in some of them." They found a fruit resembling the whortleberry, which, although insipid, was juicy, and supplied the place of water. The party were however unable to reach the summit, as they had been a day and two nights without water and saw no prospect of procuring any. After passing another night on the lava, they therefore reluctantly returned towards Kairua. In their descent, they discovered an excellent spring of water, by which the party were much refreshed. They had travelled so constantly upon the sharp points of lava, that their shoes were nearly destroyed, and they returned almost barefoot to the Governor's at Kairua. Although the attempt to reach the summit of the mountain was unsuccessful, the excursion gave them the fullest evidence of the volcanic origin of this region. On the 16th of July, Messrs. Goodrich and Harwood, from the extremities of a base line of 2,230 feet, made two observations, by which they made the height of the mountain 7,882 feet, but as their quadrant was not a good one, it was concluded that the real height exceeded this. The mountain is, however, never covered with snow.

On the 18th of July they proceeded forth on their journey, and about the middle of the day, near Kahalu, they "travelled about a mile across a rugged bed of lava, which had evidently been ejected from a volcano, more recently than the vast tracts of the same substnce, by which it was surrounded. It also

appeared to have been torn to pieces, and tossed up in the most confused manner, by some violent convulsion of the earth, at the time it was in a semi-fluid state. There was a kind of path formed across the most level part of it, by large, smooth, round stones, brought from the sea shore, and placed three or four feet apart. By stepping from one to another of these we passed (as they remark) over the roughest pieces of lava we had yet seen."

On the 19th their way lay over a rough tract of lava, resembling that which they passed the day before.—They go on to relate:

"In many places, it seemed as if the surface of the lava had become hard, while a few inches underneath, it had remained semi-fluid, and in that state had been broken up, and left in its present confused and rugged form. The rugged appearance of the lava was probably produced in part, by the expansive force of the heated air beneath the crust of lava, but this could not have caused the deep chasms and fissures which we saw in several places; we also observed many large spherical volcanic stones, the surface of which had been fused, and in some places had peeled off, like a crust or shell, an inch or two in thickness. The centre of some of these stones, which we broke, was of a dark blue colour, and clayey texture, and did not appear to have been at all affected by the fire."

On the 21st of July, the travellers arrived at the spot where, in the year 1780, Tamahameha gained a decisive victory over his cousin and rival Kauikeouli, and thus laid the foundation of his power. The battle lasted eight days, and "the scene of this sanguinary engagement was a large tract of rugged lava, the whole superficies of which had been broken up by an earthquake."

On the 24th, near Keakoa, a singular appearance of the lava attracted the attention of the party. "It consisted of a covered avenue of considerable extent, from 50 to 60 feet in height, formed by the lava's having flowed, in some recent eruption, over the edge of a perpendicular stratum of very ancient lava, from 60 to 70 feet high. It appeared as if it had at first flowed over in one vast sheet, but had afterwards fallen more slowly, and in detached semi-fluid masses. These, cooling as they fell, had hardened and formed a pile, which, by continued augmentation from above, had ultimately reached the top, and united with the liquid lava there. It was evident that the lava still continued to flow along the outside of the

arch thus formed, into the plain below, as we observed, in several places, the course of unbroken streams, from the top of the cliff, to the bed of smooth lava, that covered the beach for several miles. The space at the bottom, between the ancient rocks and more recently formed lava, was from six to twelve feet. On the one side, the lava rose perpendicular and smooth, showing distinctly the variously coloured strata, of which it was composed; some of a bright scarlet, others brown and purple. The whole mass appeared to have undergone, since its formation, the effects of violent heat. The cracks and hollows, horizontally between the different strata, or obliquely through them, were filled with lava, of a florid red colour, and much less porous than the general mass. It must have been brought to a state of most perfect liquefaction, as it had filled up every crevice that was more than half an inch wide. It appeared highly glazed, and in some places we could discover small round pebbles, from the size of a hazel nut to that of a hen's egg, of the same colour, and having the same polish, yet seeming to have remained solid, while the liquid lava, with which they were mixed, had been forced by subterranean fire, into all the fissures of the ancient rock.

The pile on the other side, formed by the dripping of the lava from the upper edge of the rocks, presented a striking contrast, but not a less interesting scene. It was generally of a dark purple, or jet black colour, glittering in the rays of the sun, as if glazed over with a beautiful vitreous varnish. On breaking any fragments of it, we found them very porous, and considerably lighter than the ancient lava, on the other side. Its varied forms baffled description, and were equal to the conceptions of the most fertile imagination. The archway thus formed, extended for about half a mile, occasionally interrupted by an opening in the pile of lava, caused by some projecting rock, or elevation in the precipice above. A spectacle awfully sublime and terrific, must have been presented, when this burning stream rolled in one wide sheet, a fiery cascade, from the lofty steep, down upon the smoking plain. With what consternation and horror must it have filled the afflicted inhabitants of the surrounding villages, as they beheld its irresistible and devastating course, impressed as they were, with the belief that Pele, the goddess whom they had offended, had left her abode in the volcanoes, and was in person visiting them with thunder, lightning, earthquake, and liquid fire, the instruments of her power and vengeance. As we passed along this

vaulted avenue, called by the natives Keanaee, we beheld a number of caverns and tunnels, from some of which, streams of lava had flowed. The mouths of others being walled up with stones, we supposed were used as sepulchres. Mats spread upon the slabs of lava, calabashes, &c., indicated some of them to be the habitations of men; others, near the openings, were used as workshops, where women were weaving mats, or beating cloth. Some we also saw used as store-houses, or depositories of sandal wood. In many places, the water filtered through the lava, and around the spots where it had dropped upon the ground, we observed a quantity of very fine, white, spear-shaped crystals, of a sharp nitrous taste. Having walked a considerable distance along the covered way, and collected as many specimens of the lava as we could conveniently carry, we returned to the sea shore, the path along which was often tedious and difficult. The lava frequently presented a mural front, from 60 to 100 feet in height, in many places hanging over our heads, apparently every moment ready to fall; while beneath us the long rolling billows of the Pacific chaffed and foamed among the huge fragments, along which our road lay. In many places, the lava had flowed in vast torrents over the top of the precipice into the sea. Broad flakes of it, or masses like stalactites, hung from the projecting edge in every direction. The attention was also attracted by a number of apertures in the face of the rocks, at different distances from their base, looking like so many glazed tunnels, from which streams of lava had gushed out, and fallen into the ocean below, probably at the same time that it had rolled down in a horrid cataract from the rocks above.

On the 25th, Messrs. Thurston, Goodrich and Bishop continued their journey along the shore, which was "literally iron-bound." It was formed of steep rocks of lava, whose surface wore the most rugged aspect imaginable. About 2 P. M. they passed Taureonahoa, three large pillars of lava, about 20 feet square, and 80 or 100 high, standing in the water within a few yards of each other, and adjacent to the shore. Two of them were united at the top, but open at their base. The various coloured strata of black, reddish and brown lava being distinctly marked, looked like so many distinct courses of masonry."

After leaving Kalahiti, they "proceeded over a very rugged tract of lava, broken up in the wildest confusion, apparently by an earthquake, when it was in a semi-fluid

state. About noon they passed a large crater. Its rim, on the side towards the sea, was broken down, and the streams of lava issuing thence, marked the place by which its contents were principally discharged. The lava was not so porous as that of Keanaee; but, like much in the immediate vicinity of the craters, was of a dark red, or brown ferruginous colour, and but partially glazed over." For a mile along the coast, they found it impossible to travel without making a considerable circuit inland, and they continued to pursue their way over a broken and rugged tract of lava.

In this volcanic country, the want of fresh water is severely felt, and was often experienced by the missionaries during their tour.

On the 26th, at Kapua, they hired a man to go about seven miles into the mountains, for fresh water; but he returned with only one calabash full, a very inadequate supply for the party, who had suffered much from thirst, and the effects of brackish water. They now entered the district of Kau, and turning the southern point of the Island, found "the same gloomy and cheerless desert of rugged lava, spreading itself in every direction, from the shore to the mountains. Here and there at distant intervals they passed a lonely house, or a few wandering fishermen's huts, with a solitary shrub of thistles struggling for existence among the crevices in the blocks of scoria and lava: all besides was one vast desert, dreary, black and wild. Often all traces of a path entirely disappeared. For miles together, they clambered over huge pieces of vitreous scoria, or rugged piles of lava, which like several of the tracts they had passed in Kana, had been tossed into its present confusion by some violent convulsion of the earth."

Their narrative proceeds: "From the state of the lava, covering that part of the country, through which we have passed, we should be induced to think, that eruptions and earthquakes had been almost without exception, concomitants of each other; and the shocks must have been exceedingly violent, to have torn the lava to pieces and shaken it up in such distorted forms, as we every where beheld. "Slabs of lava from nine to twelve inches thick, and from four to twenty or thirty feet in diameter, were frequently piled up edgewise, or stood leaning against several others, piled up in a similar manner." "Some of them were six, ten, or twelve feet above the general surface, fixed in the lava below, which

appeared to have flowed round their base, and filled up the interstices occasioned by the separation of the different pieces. One side of these rugged slabs generally presented a compact, smooth, glazed, and gently undulated surface, while the other appeared rugged and broken, as if torn with violence from the viscid mass, to which it had tenaciously adhered. Probably these slabs were raised by the expansive force of heated air, or of steam, beneath the sheet of lava." "A number of conical hills, from 150 to 200 feet high, rose immediately in our rear, much resembling sand hills in their appearance. On examination, however, we found them composed of volcanic ashes and scoria; but could not discover any mark of their ever having been craters." So common were streams and masses of lava wherever the missionaries travelled, that upon this harsh substance they almost always walked, sat and slept. On the evening of the 26th, they spread their "mats upon the lava, and lay down to sleep under the canopy of heaven." A pile of blocks, of scoria, and lava; part of which they had themselves erected, screened their heads from the wind.

The company were much distressed for want of water, but were relieved by the natives, who appear to have been uniformly kind and hospitable.

After leaving Keavaiti on the 27th, "Messrs. Thurston, Bishop, and Goodrich travelled over the rugged lava, till the moon becoming obscured by dark, heavy clouds, they were obliged to halt under a high rock of lava, and wait the dawn of day; for, they found it impossible to proceed in the dark, without being every moment in danger of stumbling over the sharp projections of the rocks, or falling into some of the deep and wide fissures that intersected the lava in every directed. During the whole of the 27th, a most beautiful spouting of the water attracted the attention of the travellers. It was produced by the rolling of the waves of the sea, which, through an aperture of about two feet in diameter, every few seconds threw up a volume of water with considerable noise, and a pleasing effect, to the height of thirty or forty feet. The lava at this place was very ancient, and much heavier than that at Kona. The vesicles were completely filled with olivin.

Almost every incident connected with this interesting tour is in some way associated with lava. Villages and funeral piles, and sanctuaries of refuge were built upon lava. This substance was often the missionary's pulpit, when he preach-

ed, and the seat of the people while they heard the tidings of salvation, and at night, the pilgrims often sought repose upon this rough and pointed bed. Incessant almost, as was its recurrence, it often presented something new or more striking than what had appeared before. On the 30th they travelled over another tract of lava "about 200 rods wide, which had been violently torn to pieces, and thrown up in the wildest confusion. In some places it was heaped forty or fifty feet high. The road across it was formed of large, smooth, round stones, placed in a line two or three feet apart." On these the missionaries passed over, by stepping from one to another, but not without considerable fatigue. They were shown the place where, in one of the wars of Tamehamaha, a party of his enemies, about 80 men, being the warriors of two villages, were, during their repose at night, destroyed by a volcanic eruption.

In their progress along the south-eastern side of the island, they arrived at the village of Milone, celebrated on account of a short pebbly beach called Shoroa. Of these stones they had been accustomed to form, not only cutting instruments, but to fabricate gods. It required considerable skill to select those which would answer, and as they were supposed to be endowed with sex, one of each kind was selected, when they were about to be transformed into gods. They were wrapped up together in a piece of cloth, and after a certain time, a small stone was found with them, which, when grown to the size of its parents, was taken to the heiau and made afterwards to preside at the games.

Although the climate of Hawaii is hot, and the thermometer on the evening of July 31st stood at 70°, the air from the mountains soon became so keen that, although in a tropical climate, they found a fire very comfortable.

As they were travelling upon the high land, they perceived a number of columns of smoke and vapour rising at a considerable distance, and also one large steady column that seemed little affected by the wind, and which, as they were told, arose from the great crater of Kirauea.

The next day three of the party visited the places where they had seen the columns of smoke rising the day before.

They travelled five miles over a considerably fertile and cultivated country, the soil of which was composed of the decomposed surface of a bed of ancient lava, upon which shrubs and trees had grown to a considerable height. As they

approached the places from which the smoke issued, they passed over a number of fissures or chasms, from two inches to six feet in width. "The whole mass of rocks had evidently been rent by some violent convulsion of the earth, at no very distant period," and when they came in sight of the ascending columns of smoke and vapour, they beheld, immediately below, a valley or hollow, about half a mile across, formed by the sinking down of the whole surface of ancient lava to the depth of fifty feet below its original level. It was intersected by narrow fissures, running in every direction, and two ran from the mountain towards the sea, as far as the eye could reach. From the wider portions of these fissures, where they were about ten or twelve feet in width, the smoke arose. As they descended into the valley the ground sounded hollow, the lava cracked under their feet, and soon grew (as they proceeded) so hot that they could not stand more than a minute or two in a place.

Their guide, terrified by the smoke and vapour that issued from one of the apertures, refused to go any farther, remonstrating against the audacity of the strangers, who presumed thus to provoke the anger of the goddess Pele, the local deity of the volcano, although the guide retreated to the bushes at the edge of the valley, while the travellers proceeded. They passed as near as the smoke and sulphureous vapours would permit, to several of the fissures. Although they looked into several, it was only in three that they could see any bottom. These appeared to be about 50 or 60 feet deep, and contained red hot stones that had fallen in, and they thought they saw flames, but the smoke and heat were so great, that it was difficult to look long. Their hands, legs, and faces were nearly scorched by the heat.

They walked along the hollow for nearly a mile, and arrived at a chasm from which lava had very recently issued, both in projected fragments and in streams.

"The appearance of the tufts of long grass, through which it had run; the scorched leaves still remaining on one side of a tree, while the other was reduced to charcoal; and the strings of lava hanging from some of the branches like stalactites; together with the fresh appearance of the shrubs, partially overflowed and broken down, convinced them that the lava had been thrown out only a few days before. It was of a different kind, from the ancient bed of which the whole valley was composed, being of a jet black colour and

bright variegated lustre, brittle and porous; while the ancient lava was of a gray or reddish colour, compact, and broken with difficulty."

The heat varied at the surface, which they attributed to the varying thickness of the lava, beneath the whole of which, the heat was still in great activity, as was evinced by the volumes of smoke and vapour every where issuing. Of this place Mr. Ellis took a drawing.—

It appeared from the statement of the guide, that about eleven moons ago, the two large chasms were formed, and that the great hollow had been formed by the subsidence of the earth, about two moons ago, in consequence of an earthquake. The missionaries regarded this as an infant volcano, which seems, however, to have remained mainly undisturbed for a long time, perhaps for ages; for "the lava is decomposed to a considerable depth, and is mingled with prolific soil, fertile in vegetation, and profitable to its proprietors." We felt, they observe—"a melancholy interest in witnessing the first exhibitions of returning action, after so long a repose in this mighty agent, whose irresistible energies will probably, at no very distant period, spread desolation over a district, now smiling in verdure, repaying the toils and gladdening the heart of the industrious cultivator." The place which the missionaries had visited, is about 10 or 12 miles from the sea shore, and about 20 from the great volcano, at the foot of Mouna Roa.

As they returned, they "passed several hills, whose broad base and irregular tops, showed them originally to have been craters. They must have been very ancient, as they were covered with shrubs and trees. From them must have come the then molten, but now indurated floods, over which the party had been travelling."

Having made every preparation to visit the great crater of Kirauea, the party set forward at 5 P. M. of July 31.

At a place called Kapuahi, they "stopped at the entrance of a large cave, arched over by a thick crust of ancient lava." This cave, although with no other light than that which entered at the mouth, was inhabited permanently by entire families—whose members were cheerfully employed in domestic industry within, while the children were playing among the fragments of lava, without. Although very poor, they imparted to the travellers both fresh water and taro root.

The progress of the party was now over a most beautiful

country, which, to the right, sloped gradually for ten or fifteen miles to the ocean, and rose abruptly to the left, "where it was crowned with the woods, which extend, like a vast belt, round the base of Mouna Roa. At the distance of three or four miles they came to another cavern in the lava, called Keapuana, which is often used as a lodging place for benighted travellers. "The entrance, which was eight feet wide and five high, was formed by an arch of ancient lava. The interior of the cavern was about fifty feet square, and the arch that covered it was ten feet high. There was an aperture at the northern end, about three feet in diameter, occasioned by the falling in of the lava, which admitted a current of keen mountain air, through the whole of the night. While they were cleaning out the small stones between some of the blocks of lava, that lay scattered around, a large fire was kindled near the entrance, which, throwing its glimmering light on the dark volcanic sides of the cavern, and illuminating one side of the huge masses of lava, exhibited to our view the strange features of our apartment, which resembled in no small degree, scenes described in tales of romance."

From the higher regions in the vicinity of the cave, the light of the volcano illuminating the clouds, was distinctly visible.

On the morning of Aug. 1, the party ascended from their subterranean dormitory, and directed their course N. N. E. towards the smoke. "The path, (they remark,) for several miles, lay through a most fertile tract of country, covered with bushes or tall grass, and fern from three to five feet high, and so heavily laden with dew, that before we had passed it, we were as completely wet as if we had been drawn through a river. The morning air was cool, and the singing of birds enlivened the woods. After travelling a short distance over the open country, we came to a small wood, into which we had not penetrated far, before all traces of a path entirely disappeared. We kept on some time, but were soon brought to a stand by a deep chasm, over which we saw no means of passing. Here the natives ran about in every direction, searching for marks of footsteps, just as a dog runs to and fro, when he has lost the tracks of his master. After searching about half an hour, they discovered a track, which led considerably to the southward, in order to avoid the chasm in the lava. Near the place where we crossed over, was a cave of considerable extent. In several places, drops

of water, beautifully clear, constantly filtered through the arch, and fell into calabashes placed underneath to receive it. Unfortunately for us, these were all nearly empty: probably some traveller had been there but a little time previous. Leaving the wood, we entered a waste of dry sand, about four miles across. The travelling over it was extremely fatiguing, as we sunk to our ancles at every step. The sand was of a dark olive colour, fine and sparkling, adhered readily to the magnet, and being raised up in every direction, presented a surface resembling (colour excepted,) that of drifted snow. It was undoubtedly volcanic, but whether thrown out of any of the adjacent craters, in its present form, or made up of small particles of decomposed lava, and drifted by the constant trade-winds from the vast tract of lava to the eastward, we could not determine. Having refreshed ourselves, we resumed our journey, taking a northerly direction towards the columns of smoke, which we could now distinctly perceive. Our way lay over a wide waste of ancient lava, of a black colour, compact and heavy, with a shining vitreous surface, frequently thrown up by the expansive force of vapour or heated air, into conical mounds, from six to twelve feet high, which were rent in a number of instances from the *apex* to the *base*. The hollows between the mounds and long ridges, were filled with volcanic sand, or fine particles of decomposed lava. It presented before us a sort of island sea, bounded by mountains in the distance. Once it had certainly been in a fluid state, but appeared to have become suddenly petrified, or turned into a glassy stone, while its agitated billows were rolling to and fro. Not only were the large swells and hollows distinctly marked, but in many places the surface of these billows was covered by a smaller ripple, like that observed on the surface of the sea, at the first springing up of a breeze, or the passing currents of air, which produce what the sailors call a "cats-paw." The sun had risen now in his strength, and his bright rays reflected from the sparkling sand; an undulated surface of the vitreous lava dazzled our eyes, and caused considerable pain, particularly as the trade wind blew fresh in our faces, and continually drove particles of sand into our eyes. This part of our journey was unusually laborious, not only from the heat of the sun, and the reflection from the lava, but also from the unevenness of the surface, which obliged us constantly to tread on an inclined plain, in some places as smooth, and almost as slippery as glass, where the

greatest caution was necessary to avoid a fall: frequently we chose to walk along on the ridge of a billow of lava, though considerably circuitous, rather than pass up and down its polished sides. Taking the trough or billow between the waves, we found safer, but much more fatiguing, as we sank every step deep into the sand. Between eleven and twelve o'clock we passed a number of conical hills on our right, which the natives informed us were craters. A quantity of sand was collected around their base, but whether thrown out by them, or drifted thither by the wind, they could not inform us. In their vicinity, we also passed several deep chasms, from which, in a number of places, small columns of vapour arose at different intervals. They appeared to proceed from Kirauea, the great volcano, and extended towards the sea, in a S. E. direction. Probably they are connected with Pouahohoa, and may mark the course of a vast subterraneous channel, leading from the volcano to the shore. The surface of the lava on both sides was considerably heated, and the vapour had a strong sulphureous smell.

We continued our way, beneath the scorching rays of a vertical sun, till about noon, when we reached a solitary tree, growing in a bed of sand, and spreading its roots among the crevices of the lava. We threw ourselves down, stretched out our weary limbs beneath its grateful shade, and drank the little water left in our canteens.

In every direction around us, we observed a number of pieces of spumous lava, of an olive colour, extremely cellular, and as light as a sponge. They appeared to have been drifted by the wind into the hollows which they occupied. The high bluff rocks on the north-west side of the volcano, were very distinctly seen; the smoke and vapour driven past us, and the scent of the fumes of sulphur, which, as we approached from the leeward, we had perceived ever since the wind sprung up, were now very strong, and indicated our approach to Kirauea. Impatient to view it, we rose, after resting about half an hour, and pursued our journey. By the way-side we saw a number of low bushes, bearing beautiful red and yellow berries in clusters, each berry being about the size and shape of a large currant. The native name of the plant is *Ohelo*.

We travelled on, clearing every Ohelo bush that grew near the path, till about 2 P. M. when the great CRATER OF KIRAUEA all at once burst upon our view. We expected to

have seen a mountain with a broad base, and rough indented sides, composed of loose slags or streams of lava, and whose summit would have presented a rugged wall of scoria, forming the rim of a mighty cauldron. But instead of this, we found ourselves on the edge of a steep precipice, with a vast plain before us, fifteen or sixteen miles in circumference, and sunk from 200 to 400 feet below its original level. The surface of the plain below was uneven, and strewed over with large stones, and volcanic rocks; and in the centre of it was the great crater, a mile or a mile and a half distant from the precipice, on which we were standing. Our guides led us round towards the north end of the ridge, in order to find a place by which we might descend to the plain below. As we passed along, we observed the natives, who had hitherto refused to touch any of the ohelos, now gather several bunches, and after offering a part to Pele, they eat them freely. They did not use much ceremony in their acknowledgement, but when they had plucked a bunch containing several clusters of berries, they made a stand, with their faces turned towards the place where the greatest quantities of smoke and vapour issued, and breaking the branch they held in their hand in two pieces, they threw one part down the precipice, saying at the same time, "E Pele eia ka ohelo au; e taumaha aku wau ia oe, e ai hoi au tetaki;" ("Pele, here are your ohelos; I offer some to you, some I also eat.")

We walked on to the north end of the ridge, where the precipice being less steep, a descent to the plain below seemed practicable. It required, however, the greatest caution, as the stones and fragments of rocks frequently gave way under our feet, and rolled down from above; and with all our care we did not reach the bottom without several falls and slight bruises. The steep which we had descended, was formed of volcanic materials, apparently a light red, and gray kind of lava, vesicular, and lying in horizontal strata, varying in thickness from one to forty feet. In a small number of places, the different strata of lava were, also, rent in perpendicular or oblique directions from the top to the bottom, either by earthquakes or other violent convulsions of the earth, connected with the action of the adjacent volcano. After walking some distance over the sunken plain, which, in several places, sounded hollow under our feet, we came suddenly to the edge of the great crater, where a spectacle, sublime and appalling, presented itself before us. Astonishment and awe

for some moments deprived us of speech, and, like statues, we stood fixed to the spot, with our eyes rivetted on the abyss below. Immediately before us yawned an immense gulph, in the form of a crescent, upwards of two miles in length, about a mile across, and apparently eight hundred feet deep. The bottom was filled with lava; and the south-west and northern parts of it were one vast flood of liquid fire, in a state of terrific ebullition, rolling to and fro its "fiery surge," and flaming billows. Fifty-one craters, of varied form and size, rose, like so many conical islands from the surface of the burning lake. Twenty-two constantly emitted columns of gray smoke, or pyramids of brilliant flame, and many of them at the same time vomited from their ignited mouths, streams of fluid lava, which rolled in blazing torrents down their black indented sides, into the boiling mass below. The sides of the gulph before us, were perpendicular for about 400 feet, when there was a wide horizontal ledge of black, solid lava, of irregular breadth, but extending quite around. Beneath this black ledge, the sides sloped towards the centre, which was, as nearly as we could judge, 300 or 400 feet lower. It was evident that the crater had recently been filled with liquid lava up to this black ledge, and had, by some subterranean canal, emptied itself into the sea, or inundated the low land on the shore. The gray, and in some places, apparently calcined sides of the great crater before us; the fissures which intersected the surface of the plain, on which we were standing; the long banks of sulphur, on the opposite side; the numerous columns of vapour and smoke, that rose at the north and south end of the plain, together with the ridge of steep rocks, by which it was surrounded, rising probably, in some places, 400 feet in perpendicular height, presented an immense volcanic panorama, the effect of which was greatly augmented by the constant roaring of the vast furnaces below.

We then walked along the western side of the crater in search of water, which we had been informed was to be found in the neighborhood, and succeeded in finding three pools, where the water was perfectly fresh and sweet. These pools appeared great natural curiosities. The surface of the ground in the vicinity was perceptibly warm, and rent by several deep, irregular chasms, from which steam and thick vapours continually arose. In some places these chasms were two feet wide. From thence a dense volume of steam ascended, which was immediately condensed into small drops of

water, by the cool mountain air, and driven like drizzling rain into hollows in the lava, at the leeward side of the chasms. The pools, which were six or eight feet from the chasms, were surrounded and covered by flags, rushes, and tall grass. Nourished by the moisture of the vapours, these plants flourished luxuriantly, and, in their turn, sheltered the pools from the heat of the sun, and prevented evaporation. We expected to find the water warm; but in this respect we were also agreeably disappointed. When we had quenched our thirst with water thus distilled by nature, we directed the natives to build a hut for us to pass the night in, in such a situation as to command a view of the burning lava; and while they were thus employed, we prepared to examine the many interesting objects around us. Mr. Thurston visited the eastern side of the great crater; and Messrs. Ellis and Goodrich went to examine some extensive beds of sulphur at the north-east end. After walking about three quarters of a mile over a tract of decomposed lava, covered with ohelo bushes, they came to a bank about 150 yards long, and, in some places upwards of 30 feet high, formed of volcanic sulphur, with a small proportion of red clay. The ground was hot, its surface rent by fissures; and they were sometimes completely enveloped in the thick vapours that continually ascended. A number of apertures were visible along the whole extent of the bank of sulphur; smoke and vapours arose from these fissures; and the heat around them was more intense than in any other part. They climbed about half way up the bank, and endeavoured to detach some parts of the crust, but soon found it too hot to be handled. However, by means of their walking sticks, they broke off some curious specimens. Those procured near the surface were crystallized in beautiful circular prisms of a light yellow colour, while those found three or four inches deep in the bank, were of an orange yellow, generally in single or double tetrahedral pyramids, and full an inch in length.

A singular hissing and cracking noise was heard among the crystals, whenever the outside crust of sulphur was broken, and the atmospheric air admitted. The same noise was produced among the fragments broken off, until they were quite cold. The adjacent stones and pieces of clay were frequently incrusted, either with sulphate of ammonia, or volcanic sal ammoniac. A considerable quantity was also found in the crevices of some of the neighbouring rocks, which was

much more pungent than that exposed to the air. Along the bottom of the sulphur bank, they found a number of pieces of tufa, extremely cellular and light. A thick fog now came over, which being followed by a shower of rain, obliged them to leave this interesting laboratory of nature, and return to their companions.

They saw flocks of wild geese, which came down from the mountains and settled among the ohelo bushes: they were informed that they were numerous in the interior, but were never seen on the coast.

At sun-setting, although the thermometer was as 69°, expecting a cold night upon the mountain, they collected fuel, and removed from a dangerous place, which the natives had superstitiously chosen for them, upon the very edge of the crater. The ground sounded hollow in every direction, frequently cracked, and in two instances actually gave way as they were passing over it, and exposed the persons, whose limbs sunk through the lava, to great danger and to some injury.

Mr. Thurston, who had been benighted at some distance, found his way back, directed by the fire, but not without experiencing great difficulty from the "unevenness of the path, and the numerous wide fissures in the lava." They now partook with cheerfulness of their evening repast, and afterwards, amidst the whistling of the winds around, and the roaring of the furnace beneath, offered up their evening sacrifice of praise. "Between nine and ten, the dark clouds and heavy fog, that, since the setting of the sun, had hung over the volcano, gradually cleared away, and the fires of Kirauea, darting their fierce light across the midnight gloom, unfolded a sight terrible and sublime beyond all they had yet seen."

"The agitated mass of liquid lava, like a flood of melted metal, raged with tumultuous whirl. The lively flame that danced over its undulating surface, tinged with sulphureous blue, or glowing with mineral red, cast a broad glare of dazzling light on the indented sides of the insulated craters, whose bellowing mouths, amidst rising flames and eddying streams of fire, shot up at frequent intervals, with loudest detonations, spherical masses of fusing lava, of bright ignited stones. The dark, bold outline of the perpendicular and jutting rocks around, formed a striking contrast with the luminous lake below, whose vivid rays, thrown on the rugged promon-

tories, and reflected by the overhanging clouds, combined to complete the awful grandeur of the imposing scene."

They sat "gazing at the magnificent phenomenon for several hours, when they laid themselves down on mats, to observe more leisurely its varying aspect; for, although they had travelled upwards of twenty miles since the morning, and were both weary and cold, they felt little inclination to sleep. The natives, who probably viewed the scene with thoughts and feelings somewhat different from theirs, seemed however equally interested. They sat most of the night, talking of the achievements of Pele, and regarding with a superstitious fear, (at which we were not surprised,) the brilliant exhibition. They considered it the primeval abode of their volcanic deities. The conical craters, they said, were their houses, where they frequently amused themselves by playing at *konane*. The waving of the furnaces and the crackling of the flames, were the *kaui* of their *hura*, (music of their dance,) and the red flaming surge was the surf wherein they played, sportively swimming on the rolling wave."

The natives said, that according to tradition, the volcano had been burning from chaos, or night, till now—for they refer the origin of the world, and even of their gods, to chaos, or night; and the creation was, in their view, a transition from darkness to light. They stated that, in earlier ages, the volcano "used to boil up, to overflow its banks, and inundate the adjacent country; but that, for many kings' reigns past, it had kept below the level of the surrounding plain, continually extending its surfaee, and increasing its depth, and occasionally throwing up, with violent explosion, huge rocks, or red hot stones. These eruptions, they said, were always accompanied by dreadful earthquakes, loud claps of thunder, and vivid and quick succeeding lightning. No great explosion, they added, had taken place since the days of Keona, but many places near the sea-shore had been overflowed; on which occasions, they supposed that Pele went, by a road under ground, from her house in the crater to the shore.

The mythology of Hawaii is much interwoven with the phenomena of their volcanoes and earthquakes, and with the thunder and lightning by which they are accompanied. It is easy to trace in their absurd and extravagant fables respecting the contests of Pele, the goddess of volcanoes, with opposing powers, the physical conflict of fire and water, and of

the various elemental agents, and certainly these fables are recommended to a poetical imagination, by much that is splendid and grand.

Whenever the natives spoke of those gods of fire, it was as "dreadful beings." They reside in all the volcanoes, but chiefly in that of Kirauea. They never travelled on journies of mercy, but always on those of wrath. Earthquakes, thunder and lightning announced their approach: sacrifices were made to appease their anger. Hundreds of hogs, both cooked and living, were thrown into the craters, when they threatened an eruption; and during an inundation, multitudes were thrown into the rolling torrent of lava, to stay its progress.

When these infernal gods were enraged, "they filled Kirauea with lava, and spouted it out; or taking a subterraneous passage, marched to some one of their houses (craters) in the neighbourhood; and thence came down upon the delinquents, with all their dreadful scourges."

On the 2d of August, the provisions of the party being exhausted, they prepared for an immediate return; but they endeavoured previously to ascertain in the best manner they could, the size of the crater. They estimated it at 5 miles, or $5\frac{1}{2}$ in circumference, but the more accurate measurement of Mr. Goodrich, mentioned in his letter, makes it $7\frac{1}{2}$. The depth of the crater, they estimated at 700 or 800 feet; but Mr. Goodrich fixes it at more than 1000.

The travellers "threw down several large stones, which, after several seconds, struck on the sides, and then bounded to the bottom, where they were lost in the lava. Some of them were as large as they could lift; yet, when they reached the bottom, they appeared like pebbles, and they were obliged to watch their course very steadily to perceive them at all.

The party separated into two divisions; one pursued the path along the edge of the crater, towards the sea shore. The path was in many places dangerous, lying along narrow ridges, with fearful precipices on each side; or across deep chasms and hollows, that required the utmost care to avoid falling into them, and where a fall would have been certain death, as several of the chasms seemed narrowest at the surface. In one place they passed along for a considerable distance under a high precipice, where the impending rocks towered some hundred feet above them on their left, and the appalling flood of lava rolled almost beneath on the right. On this side they descended to small craters on the declivity, and

also to the black ledge; where they collected a number of beautiful specimens of lava, generally of a black or red colour, light, cellular, brittle, and shining. They also found a quantity of volcanic glass, drawn out into filaments as fine as human hair, and called by the natives *rouoho o Pele*, (hair of Pele.) It was of a dark olive colour, semi-transparent, and brittle, though some of the filaments were several inches long. Probably it was produced by the bursting of igneous masses of lava, thrown out from the craters, or separated in fine spun thread, from the boiling fluid, when in a state of perfect fusion, borne by the smoke above the edges of the crater, and thence wafted by the winds over the adjacent plain, for they also found quantities of it at least seven miles distant from the crater. They "entered several small craters, that had been in vigorous action but a short period before, marks of very recent fusion presenting themselves on every side. Their size and height were various, and many, which, from the top, had appeared insignificant as mole-hills, they now found twelve or twenty feet high. The outsides were composed of bright shining lava, heaped up in piles of most singular form. The lava on the inside was of a light or dark red colour, with a glazed surface, and in several places, where the heat had evidently been intense, they saw a deposit of small and beautifully white crystals. They also entered several covered channels, down which the lava had flowed into the large abyss. They were formed by the cooling of the lava, on the sides and surface of the stream, while it continued to flow on underneath. As the size of the current diminished, it had left a hard crust of lava of various thicknesses over the top, supported by walls of the same materials on each side. The interior was beautiful beyond description. In many places they were ten or twelve feet high, and as many wide at the bottom. The roofs formed a regular arch, hung with red and brown stalactite lava, in every imaginable shape; while the bottom presented one continued glassy stream. The winding of its current, and the ripple of its surface were so entire, that, it seemed as if, while in rapid motion, the stream had suddenly stopped and petrified, even before its undulated surface could subside. They travelled along one of these volcanic chambers to the edge of the precipice, that bounds the great crater, and looked over the fearful steep down which the fiery cascade had rushed. In the space where it had fallen, the lava had formed a spacious basin, which, hardening as it cool-

ed, had retained all those forms, which a torrent of lava, falling several hundred feet, might be expected to produce on the viscid mass below."

Large rocks were scattered around, of four or five tons weight, which appeared to have been thrown out in the volcanic eruptions.

Within one hundred yards of the great crater, is another of about half the size, called little Kirauea. "Its sides were covered with trees and shrubs, but the bottom was filled with lava, either fluid or scarcely cold, and probably supplied by the great crater, as the trees, &c. on its sides, shewed that it had remained many years in a state of quiescence." It was stated that there were many others in the neighbourhood.

So hot are the ground and the air and vapours issuing from it, that the natives formerly cooked, by these means, (and it would have been considered as impious to do it by any other,) the various sacrifices offered to Pele; and even food for ordinary purposes is always cooked here, simply by burying it in the ground. This is done by the wood cutters and by the bird catchers.

Ascending a precipice of 400 feet in elevation, the party enjoyed an extensive view of this interesting country—of Mouna Roa and Mouna Kea, in the distance; and they could with a glass discover on Mouna Roa, "numerous extinguished craters, with brown and black streams of lava, over the whole extent of its surface. The higher parts were totally destitute of vegetation, though its foot was encircled, on the side nearest to them, by trees and shrubs, which extended from its base six or seven miles."

Here they took their last view of the wide-stretched sunken plain, with all its hills and banks of sulphur, its blazing craters, and its igneous lake.

"The uneven summits of the steep rocks, that, like a wall, many miles in extent, surrounded the crater, and all its appendages, showed the original level of the country, or perhaps marked the base of some lofty mountain, originally raised by the accumulation of volcanic matter, whose bowels had been consumed by fire, and whose sides had afterwards fallen into the vast furnace, where, reduced a second time to a liquified state, they had again been vomited out on the adjacent plain."

"But the magnificent fires of Kirauea, which they had viewed with such admiration, appeared to dwindle into taper

glimmerings, when they contemplated the possible, not to say probable, existence, of immense subterranean fires immediately beneath them. The whole island of Hawaii, covering a space of 4000 square miles, from the summits of its lofty mountains, perhaps 1500 or 1600 feet above the level of the sea,* down to the beach that is washed by the rolling wave, is, according to every observation that the travellers could make, one complete mass of lava, or other volcanic matter, in different stages of decomposition, and, perforated with innumerable apertures (or craters,) forms, perhaps, a stupendous arch, over one vast furnace, situated in the heart of a huge submarine mountain, of which the island of Hawaii is but the apex. Or possibly, the fires rage with augmented force, at the unfathomable depth of the ocean's bed; and reared through the superincumbent weight of waters, a hollow mountain, forming the base of Hawaii, and at the same time a pyramidal funnel, from the furnace to the atmosphere."

It seems rather remarkable that strawberries and raspberries, which usually flourish best in moist situations, should be found in Hawaii around the volcanic summits, and even in some cases in the vicinity of the crater. Within a few miles of Kirauea the travellers passed three or four high and rugged craters. One of them was said by the natives to have inundated the surrounding country about fourteen generations back. The sides of these craters are generally covered with verdure, while the broken irregular rocks on their surface "frowned like the battlements of an ancient castle in ruins." They descended from one escarpement to another, over lava more or less decomposed. One descent was 400 feet, and another 500, which brought them to "a tract of lava considerably decomposed and about five miles wide, at the end of which another steep appeared." Down this they descended "by following the course of a rugged current of lava, for about 800 feet perpendicular depth, when they arrived at the plain below, which was one extended sheet of lava, without shrub or bush, stretching to the north and south, as far as the eye could reach, and from four to six miles across, from the foot of the mountain to the sea." They crossed this flood of

* Admitting that snow is permanent on mountains in the torrid zone, at the height of 14,600 feet, it was supposed that this might be the height of Mouna Roa and Mouna Kea, as the tops of these mountains are covered with perpetual snow. Their summits are formed of decomposed lava, and contain numerous craters.

lava in about two hours, and arrived at a village, whose inhabitants were unwilling to believe that the travellers had not only been to Kirauea, but had broken the sulphur banks, eaten the ohelos, descended to the craters, and broken fragments of lava from them, for Pele, they said, was a dreadful being, and would certainly have avenged the insult. They were however convinced by the sight of the specimens, but said that the travellers had escaped because they were foreigners. Pele, they said had, only five moons ago, issued from a subterranean cavern—overflowed the low land of Kapapala—carried into the sea some of the inhabitants, and a huge rock nearly 100 feet high, which, a little while before, had been separated by an earthquake from the main pile. They stated that it now stands in the sea, nearly a mile from shore, its bottom fixed in lava, and its summit rising considerably above the water.

The missionaries thought it probable that the eruption here alluded to, arose from " the body of the lava, which had filled Kirauea up to the black ledge—between 300 and 400 feet above the liquid lava—that it had, at the time spoken of, been drawn off by this subterranean channel, though the distance between the great crater and the land overflowed by it, was not less than thirty or thirty-five miles."

On the 3d of August, the missionaries arrived at the village of Kaimu, where they heard from the people, a confirmation from eye witnesses of the statement as to the transportation of the great rock—" they recapitulated the contest between Pele and Tamepuaa, and related the adventures of several warriors, who, with spear in hand, had opposed the volcanic demons, when coming down on a torrent of lava."

They would not believe that the travellers had dared to " break off pieces of Pele's house," and when they saw the specimens, they were not inclined to handle them.

The missionaries observed the cracks in the ground and in the houses, produced by a recent earthquake. " Earthquakes are common over the whole island, though not so frequent in this vicinity as in the northern and western parts. They are not generally violent, except when they immediately precede the eruption of a volcano." The path from Kaimu had been smooth and pleasant; but shortly after leaving Kaimali, they passed " a very rugged tract of lava, nearly four miles across. The lava seemed as if broken to pieces while cooling; it had continued to roll on like a stream of large scoria or cinders. Their progress across it was slow and fatiguing."

As the party travelled out of Puuloa, "the lava was covered with a tolerably thick layer of soil, and the verdant plain, extending several miles towards the foot of the mountains, was agreeably diversified by groups of picturesque hills, originally craters, but now clothed with grass, and ornamented with clumps of trees. The natives informed them that three of these groups, Honuaura, Malama, and Maria, being contiguous and joined at their base, arrested the progress of an immense torrent of lava, which in the days of Tajaiopu, the friend of Capt. Cook, inundated all the country beyond them."

After traversing another tract of rough lava they arrived at Kapoho, situated in an amphitheatre, once evidently a crater, but now filled with people and cottages, and smiling with verdure and cultivation. The centre was occupied by a brackish lake in which the children were swimming, sporting and diving.

On the 13th of August, near Waiakea, they observed three streams of fresh water that empty themselves into the bay of Waiakea—one rises among the summits of Mouna Kea, and the two others boil up through the lava, near the shore—fill several large fish ponds and empty into the sea.

The face of the country near Waiakea is rendered very beautiful by the frequent rains, and the long repose which this region has enjoyed from the desolating effects of volcanic eruptions.

As the travellers occasionally avoided the roughness of the land by coasting along the shores, they had opportunity to observe the bold volcanic rocks, springing up sometimes 600 feet perpendicularly from the sea—and displaying various strata of vesicular lava—from which the water was frequently seen oozing or gushing in fountains.

At Laupahoapoe they saw the ruins of a mountain of nearly 600 feet elevation, which, nine months before, had fallen into the sea in consequence of an earthquake. The cloven surface of the mountain, still in its original position, was smooth and vertical, while the fragments lay below in a state of frightful desolation, mixed with the ruins of houses, and spread for half a mile along the coast. The catastrophe, although indicated by some lambent flames that appeared at evening on the top of the rock, was so sudden, that a number of the inhabitants were involved in the consequences.

On the 25th of August, Mr. Goodrich commenced his as-

cent up Mouna Kea. The soil was formed of decomposed lava and ashes. At noon he dismissed his native companion, and taking his great coat and blanket, began to ascend the more steep and rugged parts. The way was difficult, on account of the volcanic rocks and stunted shrubs that covered the sides of the mountain. On his way up he found a number of red and white raspberry bushes, loaded with delicious fruit. At 5 P. M. having reached the upper boundary of the trees and bushes, that surround the mountain, he erected a temporary hut, kindled a small fire, and prepared for his night's repose. The thermometer, shortly after sun setting, stood at 43°, and the magnet, though it pointed north when held in the hand, was drawn two or three degrees to the eastward, when placed on the blocks of lava; owing, probably, to the great quantity of iron in the mountain.

After a few hours rest, he arose at eleven o'clock at night, and the moon shining brightly, he resumed his journey towards the summit. At midnight he saw the snow about three miles distant, directed his steps towards the place, and reached it about one o'clock on the morning of the 26th. The snow was frozen over, and the thermometer stood at 27°.

He now directed his steps towards a neighbouring peak, which appeared one of the highest, but when he had ascended it, he saw several others still higher. He proceeded towards one which appeared the highest, and bore north-east from the place where he was. On reaching the summit of this second peak, he discovered a heap of stones, probably erected by some former visitor. From this peak Mouna Roa bore south by west; Mouna Huarai, west by south; and the Island of Maui, north-west. The several hills or peaks on the summit of Mouna Kea, seemed composed entirely of volcanic matter, principally cinders, pumice, and sand. Mr. Goodrich did not discover any aperture or crater on either of the summits he visited. Probably there is a large crater somewhere on the summit, from whence the scoria, sand and pumice, have been thrown out. The whole of the summit was not covered with snow. There were only frequent patches, apparently several miles in extent, over which the snow was about eight inches or a foot in thickness. The ocean to the east and west was visible, but the high land on the north and south, prevented its being seen in those directions.

Mr. Goodrich commenced his descent about three o'clock, and after travelling over large beds of sand, and cinders, into

which he sunk more than ankle deep at every step, he reached, about sunrise, the place where he had slept the preceding evening. The descent in several places, especially over the snow, was steep and difficult, and the utmost caution was necessary to avoid a fall. In his way down, he saw at a distance, several herds of wild cattle, which are very numerous in the mountains, and inland parts of the island.

The natives said they were informed by their fathers, that all the land had once been overflowed by the sea, except a small peak on the top of Mouna Kea, where two human beings were preserved from the destruction which overtook the rest.

The analysis and abstract which we have now given of the journal of the missionaries, as regards the volcanic appearances in Hawaii, presents a series of facts, in the highest degree interesting and instructive. In vol. 4, at page 251, we gave a similar exhibition of the leading facts observed by Dr. J. W. Webster, and recorded in his very valuable and entertaining account of the Azores. Those observations were made and recorded, by a man of science, professedly investigating the natural history of the country where he was residing, and they certainly do much credit both to his industry and discrimination. It is with great pleasure that we add our warm commendation of the late effort of the missionaries. Situated in a remote island, in the vast expanse of the Pacific, intensely and ardently occupied in their great object, the moral improvement and civilization of the natives ;—remote from the lights of science, and subjected to physical privations both frequent and severe, we certainly owe them many thanks for the great amount of valuable information which they have, *incidentally*, contributed, on the subject of the natural history of one of the most remarkable volcanic regions in the world. They have, in a very pleasing manner, blended scientific instruction with moral ; and both the scientific and religious world will unite in expressing their acknowledgments to the missionaries. It is a happy illustration of the importance of uniting scientific and religious qualifications in the character of the missionary, and in our view, every important mission—especially in a *terra incognita*, (and there are many such,) should be furnished with good observers and good instruments to illustrate the different branches of natural

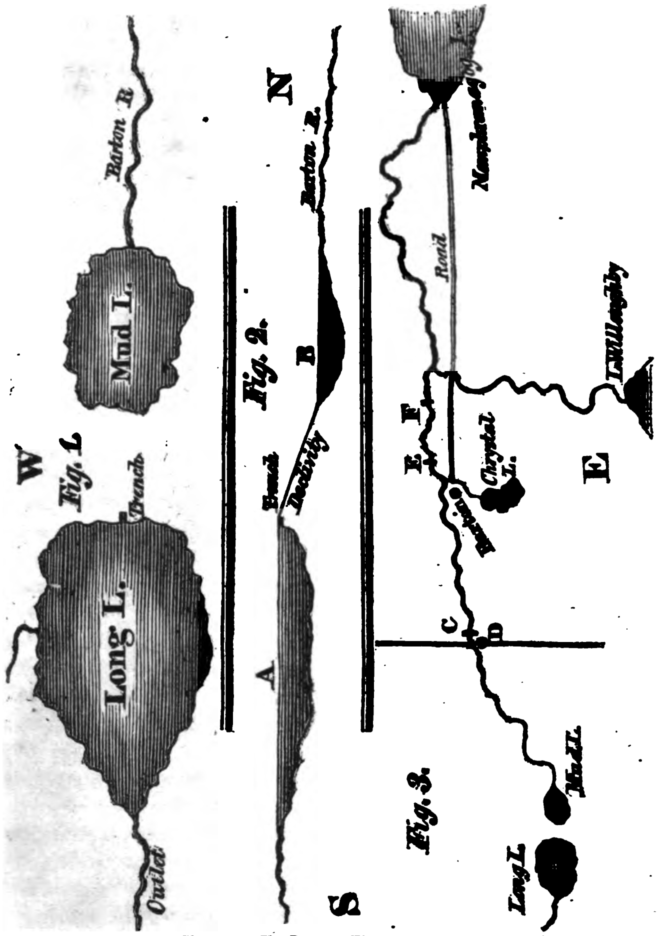
history and of physical science. It is no offence to the higher and more appropriate objects, to add, that dignity is thus shed on the mission, both in the view of the natives and in that of the civilized communities of christian countries. We are confident that many persons will peruse the late Journal of the Missionaries, in Hawaii, because it imparts so much incidental information, while no intelligent person, of whatever feelings or sentiments, will wish the amount of that information diminished.

Mineralogy and geology, botany and zoology, astronomy and geography, philology, antiquities and history, may derive very important aid from the missionaries, as indeed valuable information has often been obtained from them in years that are past.

We are gratified also with the Journal of the tour around Hawaii, on acccount of the manner in which it is written. It is a manly, perspicuous, *common-sense* book, and (very judiciously in our view) omits the colloquial epithets of personal affection, with which missionaries are wont to clothe their narratives, and which, although perfectly proper in *private* communications, appear trite and formal in the view of the world.

The missionaries did not forget to avail themselves of their superior knowledge, to enlighten, as far as possible, the dark intelligence of the Hawaiians, as to the origin of volcanoes from physical causes, operating according to the laws impressed on matter, by the omnipotent and all-wise Creator, and they strove by every means in their power, to subvert their superstitious belief in the agency of demons of fire and earthquakes, whom it was necessary to propitiate by penances, sacrifices and privations, mingled with habitual slavish fear.

We conclude by expressing the hope that we may soon be favoured with other productions, similar to that from which we have now made such copious extracts. We trust that all who may peruse these remarks, will be inclined to read the volume of the missionaries. Besides what relates to the mission, they will find very interesting notices of the scenery of the country—of its vegetable productions, and of the manners of its inhabitants. It appears that on one occasion, "the natives produced fire by rubbing two dry sticks together."



A surface of Long Lake.—B surface of Mud Lake.—C Wilson's Mill.—D Keene Corner.—E Blodget's Mill.—F Enos's Mill.

ART. II.—*Description of the Eruption of Long Lake and Mud Lake, in Vermont, and of the desolation effected by the rush of the waters through Barton River, and the lower country, towards Lake Memphremagog, in the summer of* 1810, *in a letter to the Editor.* By Rev. S. EDWARDS DWIGHT.

BOSTON, April 4, 1826.

MY DEAR SIR,

I left Burlington on Monday, Aug. 18, 1823, and proceeded on horseback, in company with Mr. ———, an alumnus of Burlington College, to Craftsbury, 60 miles; where we arrived at 2, P. M. on Tuesday. Through the kindness of my fellow traveller, an inhabitant of Craftsbury, I was able to engage a select and very agreeable party of five gentlemen to accompany me, on the succeeding day, to the bed of LONG LAKE, in the town of Glover,—the lake which was emptied of its waters in the summer of 1810. In the course of the afternoon, I had leisure to examine the local situation of Craftsbury. This village is built on a table-land, rising abruptly in the centre of a deep valley, which surrounds it on all sides, and separates it, at a moderate distance, from hills generally of the same height with itself, but occasionally aspiring to a greater elevation. This table-land is about three miles in length, and one and a half in breadth. The valley surrounding it was once probably a lake, and the table-land a large island in its centre. At present it is almost an island: one river winding more than half round it, in its progress through the valley, and a second nearly completing that part of the circuit which the first had left. Its situation is more than commonly beautiful and picturesque; and, in connexion with other more solid advantages, bids fair to render it one of the most pleasant and flourishing villages in the state. The population planted here are of a superior character; and it gratified me to learn that the village reading-room, or *athenæum*, was regularly furnished with the most important reviews and magazines of England and the United States, as well as with the gazettes of the latter. The village is well-built, and every thing indicated good order and general prosperity.

Precisely at 4, A. M. of Wednesday, I sat down with one of my companions to an excellent breakfast, which was rendered more hearty from the reflection that we might fare worse

before the day was over; and at five we were all on our horses. We rode eastward, through a country chiefly forested, twelve or fifteen miles, to a scattered hamlet in the north part of Glover, called *Keene-Corner*, and settled by emigrants from Keene, in New-Hampshire. As we began to descend from the high grounds towards this hamlet, we first saw the valley of Barton river; originally resembling the valleys of other streamlets of a similar size, but, at the time of the efflux of the lake, excavated into a broad, deep channel, with perpendicular banks; in the bottom of which the stream had worked out for itself a somewhat deeper bed. This river, which is here too small for a mill-stream, issues from Mud Lake, four miles south from Keene-Corner, and after running northward from this hamlet about seven miles to the village of Barton, turns somewhat to the north-west, flows about fifteen miles, and is discharged into Lake Memphremagog. I was most agreeably surprised, as I descended the hills which overlook the valley of the river, to find the ravages made by the flood so distinctly visible, after the lapse of thirteen years. Our first view of the desolation presented a *gulley*,* or excavation in the earth, extending up and down the river as far as its course was visible, and varying in breadth from twenty to forty rods, and in depth from twenty to forty feet. This immense channel, except what had been previously worn away by the gradual attrition of the streamlet, had all been hollowed out at once by the violence of the torrent. Its sides were precipices of earth or sand, every where indicating the avulsion of the mass which had been adjacent, and exhibiting in frequent succession, large rocks laid bare and often jutting out into the gulley; and near the top the uncovered roots of trees, which, having been partially undermined by the water, still nodded over the precipice. The bottom of this channel, as far as we could see, was covered with larger and smaller rocks and stones, and in some places with extensive deposits of sand. The sight of this vast excavation only heightened our conceptions of the effects of the flood, and satisfied us that in our visit to the bed of the lake whose waters had occasioned it, we should not be disappointed.

* The word *gulley*, is the word employed by the inhabitants to denote the deep path in the earth, which the torrent hollowed out for its own passage; and I use it for want of a better. It is, however, a word of not unfrequent occurrence.

Having engaged a dinner at a sorry substitute for an inn, we turned to the south, and ascended Barton River, about four miles. In order to see the ravages of the flood more perfectly, we left the usual path on the left bank of the gulley, and rode all the way in its bed, over ground regularly ascending, until we came upon the northern shore of Mud Lake. This lake was originally the source of Barton River, and lay directly in the path along which the waters of Long Lake flowed, at the time of its evacuation. Here, of necessity, we left the gulley, and rode along the eastern shore of Mud Lake, until we had passed it; when, resuming our route in the bed of the gulley, we found the ground ascending very rapidly, until we entered the bed of the discharged lake. Having rode about half its length, we tied our horses, and pursued our way on foot, through the middle of its bed to the southern end. Here, ascending the bank to the original water-level, we could survey the whole bed of the lake, with its shores and the surrounding scenery.

From my own personal observation, and from minute inquiries made of several individuals who were concerned in letting off the water, and of several gentlemen who were present at the legal investigation which it occasioned, I possessed myself of the following facts.

Long Lake, before it was drained, was a beautiful sheet of water, about a mile and a half in length from north to south, and, where largest, three fourths of a mile in breadth. For about five hundred yards from the southern extremity, the lake was very narrow; and to this distance its water was shoal, having been no where more than ten or twelve feet deep. Here there is a sudden and steep descent in its bed, to the depth of a hundred feet. Here also the lake opened rapidly to the breadth of half a mile, and then more gradually to three fourths of a mile. The depth also increased in the broadest part to one hundred and fifty feet, and did not diminish until within a small distance of the northern extremity, where the lake was about half a mile wide.

The eastern and western shores were bold, and rose immediately from the surface into hills of moderate height. These hills gradually subsided into plains, as they converged near the two ends of the lake, to form the northern and southern shores. The lake was supplied with water by a small rivulet, which still continues to flow in on its western side. At the southern extremity, over ground scarcely descending, and

through a channel of probably not more than a yard in width, the water of the lake flowed out in a dull streamlet toward the south-west, and between trees, shrubs and rocks, worked out for itself a sluggish passage. This was the original outlet of the lake, and the remotest head-water of the river La Moelle, a tributary of Lake Champlain. The northern shore was generally low, rising not more than five or six feet above the surface of the lake; and consisted of a narrow belt of sand, succeeded by a bank of light sandy earth. The country all around the lake, as well as along its outlet at the southern extremity, was one unbroken forest.

The distance from the northern end of Long Lake to the southern end of Mud Lake, was about two hundred rods. There was no original communication betweeen them: the waters of the former, as we have already seen, having been discharged, towards the south, and those of the latter, towards the north. The ground between the two was covered with a thick forest, and formed a very rapid declivity, from Long Lake towards Mud Lake. The low bank of sandy earth which formed the northern boundary of Long Lake, continued of an uniform height for about five rods from the shore, where, becoming more firm and solid, it descended so rapidly towards Mud Lake, that the perpendicular descent between the two, in the distance of two hundred rods, was at least *two hundred feet*.

The bottom of Long Lake near the western shore was rocky; at the southern extremity, beneath the shoal water, it was a mound of sandy earth; and throughout the great body of the lake, was either sand or mud. The mud was black, light and loose; when wet, flowing like water, and when dry, of a blue colour, and light as a cork. The descent at the northern shore was bold and rapid; and on the bottom, near the shore, was spread out a calcareous petrifaction, or deposit, called by one of the workmen a *hard-pan*, of the thickness generally of two or three inches, though occasionally of six or eight. I saw numerous fragments of it; and one, which I brought home, was an inch and a half thick, and had the solidity and hardness of limestone. Its upper surface was of a light yellowish brown colour, and had the smoothness of a stalactite; while the lower was rough and uneven, embodying pebbles, sand, weeds, and other coarse substances, on which the calcareous deposit at its first commencement had settled. The fracture, to use the sprightly language of my

principal informant, one of the individuals concerned in letting off the water, resembled *frozen gravel.*

This hard-pan, reached out from the shore into the lake, for a breadth of five or six rods, resting on the bottom ; and was found along the whole northern extremity. Being rather feebly and doubtfully sustained by the mass of sand underneath, on which it lay as on an inclined plane, it supported the superincumbent water, and formed the only solid barrier, which prohibited the contents of Long Lake from descending into Mud Lake.

Mud Lake was originally three-fourths of a mile in length from north to south, and half a mile in breadth. Its shores, both on the western and eastern sides, soon rose into high grounds ; between which, and over the bed of Mud Lake, the waters of Long Lake, if let out northward, must necessarily pass. The bottom of Mud Lake was a mass of thick deep mud, tough and gritty, of a rusty dark blue, many feet in thickness, and when dry becoming of a pale blue, and of a hard solid texture. This lake was originally deep, though less so than the other. Barton River, its outlet, descended very rapidly through a rough uneven country, over a bed of sand and pebbles, for about five miles, and then more gradually, and with a margin of meadow on each hand, for six miles, to the village in Barton. All this distance, with the exception of a few cleared spots at Keene-Corner, and in Barton, the country was in 1810 a thick forest, on both sides of the stream, to its very banks. At Keene-Corner, four miles from Mud Lake, stood a grist-mill and a saw- mill, both owned by a Mr. Wilson ; but the stream was so small that, in the dry season, the supply of water was insufficient for the mills. About 7 miles lower down, it unites with a still larger stream from the right, the outlet of Belle Pond, a beautiful lake in Barton. Two miles further down was another grist-mill, owned by a Mr. Blodget ; and three miles lower, were the mills of a Mr. Enos.

The insufficient supply of water at Wilson's mills, was a serious inconvenience to the inhabitants of Keene-Corner, as well as to the proprietor himself. The comparative elevation of the water in the two lakes, and the nature of the ground between them, had long been known at the hamlet, and had frequently provoked discussions of the question, *Whether it was not practicable to let out a part of the water of Long Lake into Mud Lake, and thus furnish an additional supply*

to the mills on Barton River. These discussions always ended in an affirmative decision; and the disposition to test its correctness regularly gaining strength, as the practicability and importance of the measure were more and more developed, it was at length resolved, in *out-of-door* convocation, that the thing should be done; and the 6th of June, 1810, the day of the general election in New-Hampshire, which, out of respect to their parent state, they had usually observed as a holiday, was selected for the purpose.

On the morning of that day, about 100 individuals from Glover, Barton, and several of the adjacent towns, assembled at Keene-Corner, with their shovels and spades, their hoes and axes, their crowbars and pick-axes, and their *canteens*, and voted that they would march to Long Lake, and there have "a regular Election *Scrape*."* They arrived at the scene of action about 10 o'clock; and having selected the spot which seemed most feasible, began to cut down the trees, and to dig a channel for the water across the belt of sandy earth which constituted the northern boundary of the lake. At 3 o'clock, a trench five feet wide, five or six rods in length, and seven or eight feet deep was completed. It began within a yard of the water, and reached to the brow of the declivity towards Mud Lake; yet gradually descended in its line of direction, so that when the small remaining mass of sand in the trench should be removed, they might see the waters of the lake flow out without interruption, to increase the mill-stream of the village.

At length, the command being given that all hands should leave the trench, the mass of sand left in it, with a portion of that under the hard-pan, were removed; and as large a piece of the hard-pan, as their pick-axes would reach, was broken off. The water issued at first through the chasm thus made, with a moderate degree of force; but to the great surprise of the workmen, it did not run off into the trench. One fact having an important bearing on the ultimate success of their enterprize, had escaped their observation. The sand under the hard-pan was a species of *quicksand;* and the issuing stream, instead of flowing obliquely towards the declivity, began to sink perpendicularly beneath the hard-pan, and to work down a portion of the quicksand, so that it disappear-

* *Scrape* in this sense is a colloquial Americanism, and denotes *a frolic.*

ed with the water.* In a few moments a large amount of the sand under the hard-pan was washed from beneath it, and the portion of the hard-pan thus undermined, being unable to sustain the immense pressure, gave way. This occasioned a violent rushing of water to the deeper outlet thus formed; which in its turn, sinking under the hard-pan, and washing down a still larger portion of the sand on which it rested, occasioned a still broader and deeper fracture of the hard-pan; and prepared the way for a still more violent gushing of the water, and a still wider and deeper gulf in the sands beneath, until all traces of the original trench had vanished. This process was repeated a considerable number of times, every fracture of the hard-pan being more extensive than the preceding; until, by the undermining force of the water, a deep gulf was worn where the trench had been, several rods in width, and descending immediately and rapidly towards Mud Lake.

Just as the efflux of the water commenced, four or five of the workmen pushed out into the lake upon a raft; intending to cross its northern end, and on their way to sound an *hurrah* becoming the occasion; but, the alarm having been given, they put to shore, and had barely left the ground on which they landed, when it disappeared. One of the others, having remained too long at work in the trench, was struck by the torrent; and the ground being washed from beneath him, he would have been carried away, had he not been caught by the hair of his head. Another, waiting too long to witness the violence of the water, was forced partly under the earth; and it was owing probably to the momentary resistance presented by the roots of a large tree, against which he was driven, that he, and those who came to his assistance, were saved. These accidents induced the workmen to retreat with rapidity from the sides of the widening gulf. In the language of one of them, they felt the ground beneath "quiver, quiver, quiver," as they ran away with all possible speed, to save their lives. Having all at length got out of danger, they stood on firm ground, near the lake, and on both sides of the widening chasm, and observed the progress of the desolation.

As the water rushed from the southern towards the northern extremity, it forced up upon the shore a large mass of

* I had all this account of the proceedings from one of the men, who was *totus in illis*.

the soft, oozy mud, several rods above the existing water-level, on either side of the outlet. This mud remained stationary for some time, and on its surface a large number of the fish of the lake lay snapping and flouncing. Just as one of the workmen was venturing into the mud to secure some of the fish, the water having chiefly run out; the two masses of mud, being no longer pressed upward by the force of water, slid down at once into the gulf, and were immediately swept away.

This process of undermining and fracturing successive portions of the hard-pan having been continued about twenty minutes, a passage was forced through it, down to its lower extremity; and the superincumbent water of the lake, being thus left wholly without support, flowed with such impetuosity towards the northern shore, that it all gave way, to the width of more than a quarter of a mile, and the depth of 150 feet. The whole barrier being thus removed, the entire mass of waters rushed out with inconceivable force and violence; and, the northern end being the deepest, it was but a few moments before a volume of water, a mile and a half in length, about three-fourths of a mile in width, and from 100 to 150 feet in depth, had wholly disappeared.

The liberated mass of water made its way down the declivity, to the valley of Mud Lake, tearing up and bearing before it, trees, earth and rocks, and excavating a channel of a quarter of a mile in width, and from 50 to 80 feet in depth. With the immense momentum which it had gained, it flowed into this valley, forcing forward, with irresistible impetuosity, the spoils which it had already accumulated; tore away masses of earth from the high grounds on each side of the lake; excavated the whole bottom of the valley, including the shores of the lake, to the depth of perhaps 30 feet; and, with the additional mass of water thus acquired, made its way down the channel of Barton River.

Mud Lake had originally a narrow outlet, and rising grounds of moderate height bounded it at the northern end. The accumulated torrent, bearing along the gathered spoils of its own desolations, broke away this mound in a moment; and following the course of the river, rushed down the long and rapid descent of five miles towards the flats in Barton. Through all this distance it tore up and carried away the forest trees, and hollowed out to itself a path in the earth, varying from 20 to 40 rods in width, and from 20 feet to 60 in

depth, so that every trace of the original bed of Barton River disappeared, and the river was left to choose for itself a new bed, many feet below the old one in the bottom of the gulley. In some instances the excavation was narrower, in consequence of huge rocks on both sides, which the torrent could not move; but in such cases, amends were made in its greater depth. Where an immoveable rock was found on one side only, it usually altered the course of the torrent, without materially diminishing its breadth. Wherever any such obstruction made an eddy, by stopping momentarily the torrent's progress, the effect was still observable in deposits of sand, immediately above the obstructions, varying in depth and extent with the time during which the water paused, and the surface which it covered at the moment. Some of these are an acre or more in extent, and 20 feet in depth. In these cases there was usually a deposit of the floating forest trees. At Keene-Corner, it not only swept away the grist-mill and saw-mill of Mr. Wilson, with the mill-dams, but the mill-sites, with all the ground beneath them for many feet, as well as the bed of the river by which they had been imperfectly supplied. A man in one of the mills, hearing the noise of the approaching flood, ran to save himself; and had but just escaped from its path, as it went by. His horse, tied at a post near the mill, was swept away, and was afterwards found a great distance below, literally torn to pieces.

About a mile below the mills, the torrent entered a more level country; where the river had been wont to glide through a broader valley, and was generally bordered with flats or intervals of some rods in width, covered with forest trees. Here this moving mass of trees, earth and water, expanded itself as the country opened, and with the velocity acquired in its long descent, marched onwards in its work of desolation. Not satisfied with tearing up the trees, it removed the earth beneath them to a considerable depth, and bore away masses of earth from the sides of the high grounds, by which the original valley of the river was bounded. These it left precipitous; exhibiting on the perpendicular face, denuded rocks and roots of trees, and in every place pointing out the exact breadth of the torrent's march. The trees on the brink, which were not destroyed, showed strong proofs of violence; proofs which were often discoverable at the end of thirteen years. Wherever the original valley narrowed, or suddenly changed its course, and its boundaries were too firm

to be pushed away; the torrent, receiving a momentary check, became narrower and higher, and left deposits of sand and of trees in the valley, and frequently on the high grounds. The forests were thus levelled, and the excavation continued some distance below the mill of Mr. Blodget, 14 miles from the lake. There, owing to the widening of the hills, and the more cleared state of the country, it gradually spent its force, though many marks of its violence are witnessed all the way to Lake Memphremagog. Through the more level country, the excavation which it left to indicate its path, varied from 30 to 60 rods in width, while its average depth was probably from 10 to 15 feet.

An inhabitant of Barton, who was standing at the time on a high ground, told me, that, hearing the noise, he looked up the stream and saw the flood marching rapidly forward, opening itself a path through the valley, and bearing a moving forest on its very top; so that those who were with him gave the alarm, that the forest from Glover was coming down upon Barton. The house of a Mr. Gould, in Barton, standing 15 feet above high-water mark, was within the track of the torrent; and himself and his wife were at home. Alarmed by the noise, he caught his wife in his arms, and carried her up the bank; yet it was with the utmost difficulty that they escaped. The water rose to the eaves of the house, and removed it from its foundation; but bearing it against some stumps of trees, which were very firmly braced in the earth, it remained there when the flood had subsided. The saw-mill of Mr. Blodget, with the mill-dam, was entirely swept away, as was every bridge on Barton river, between Mud Lake and Lake Memphremagog. At Enos's Mills, 5 miles below the village of Barton, and 17 below Long Lake, the torrent retained so much of its impetuosity that it moved a rock, supposed to be of 100 tons in weight, a number of rods from its bed.

Some of the deposits of sand were very extensive; and the changes effected by the deposition were different in different species of soil. Extensive tracts of the flats on Barton river were fine meadow land; while other tracts were sunken swamps. The former, so far as they received the deposits, were left mere fields of barren sand; while the latter were converted by them in a short time, into the richest meadows. One swamp, to the amount of two hundred acres, and several others to the amount of three hundred more, were thus recov-

ered; while various tracts of meadow, in all about one hundred acres, were permanently ruined.

Masses of wood were deposited, in greater or less frequency, along the banks of the gulley, as well as in much larger heaps in those places where the progress of the torrent was momentarily suspended. Some of the men who witnessed it, told me that tens of thousands of cords, a quantity which could not be calculated, were thus left in Barton, besides a vast amount floated further down. Near the church in Barton, a field of twenty acres was covered with deposited timber to the height of twenty feet. In several places, where the torrent was powerfully obstructed and suddenly narrowed, (as I was informed by two of the inhabitants,) the timber was piled up by the force of the stream, to the height of 60 or 80 feet. Vast quantities of it were sunk under the sand. That which lay upon the surface was burned as fast as it dried, and they had been burning it continually to clear the land; yet many acres of meadow still remained covered with timber; and I also saw numerous large heaps of it skirting the edge of either bank. The kinds of timber were spruce, cedar, hemlock and hackmontak. The trees were much bruised, the branches generally broken, and the bark pealed off; while the trees left standing near the two edges of the torrent, were principally killed.

I was informed that deposits both of wood and sand were made in this manner, on both sides of the torrent's path, all the way from Barton to Lake Memphremagog; and that large quantities of forest trees were strewed over the surface of the lake. The hard tough mud in the bottom of Mud Lake, was all forced out and carried away, and was seen scattered in smaller and larger masses—some, of the size of haycocks—for a great distance along the progress of the torrent, and over the adjoining fields.

Several of the workmen informed me that when the northern barrier of Long Lake gave way, and while the waters rushed down the declivity into Mud Lake, the convulsion shook the earth like a mighty earthquake; and that the noise was louder than the loudest thunder, and was heard for many miles around. One of them, whose house was more than five miles from the spot, told me that the noise there was so loud that the cattle came running home, with the most obvious marks of terror and alarm; and that his family supposed, until his return, that there had been a tremendous earthquake,

accompanied with loud thunder. The noise and agitation were also very great, while the torrent made its way downward, from Mud Lake to Keene-Corner; and even during its progress in the more level region, greatly alarmed all the surrounding country.

The waters of Long Lake were undoubtedly *calcareous.* I saw on the bottom many siliceous rocks; but the fissures of these rocks were frequently filled with deposits of limestone. There were numerous masses or rocks of limestone, of a blueish black colour, occasionally imbedding pebbles of a different colour and genus. Some of these masses were exceedingly hard and firm, others were only brittle, while others were friable, and others still were heaps of blueish black limestone dust—the embryos of rocks which had not yet received the cohesion necessary to bind them into solid masses, when the matrix in which they were forming was dissolved. Probably the black spongy mud of Long Lake was chiefly of this character; as this very substance, when wet, has a similar appearance. In various places on the bottom of the lake, are deposits of a friable white substance, which is almost pure carbonate of lime. This substance, as we shall have reason to see, was much more abundant before the emptying of the lake. Had a skilful mineralogist been with me, he might doubtless have made important discoveries.

The bottom of the lake was in some places boggy, but generally so dry, that we could walk over it without difficulty. It was extensively grown over with sedge and other weeds, and in many places with shrubs and young trees. The original water-level of the lake, was generally discoverable along the shores. The same rivulet still flows in on the west side, which originally supplied its waters; but it now flows out at the northern end into Mud Lake. It is about a yard over; and, as no reason can be given why it should have diminished, I conclude that this was the size of the outlet of Long Lake. The flood left obvious traces of its violence within the bed of the lake. At the southern end, the water on the shoal, not more than 10 or 12 feet deep, rushing down the pitch into the deeper part of the lake, swept down a considerable mass of earth and rocks, and near the middle of the pitch, from east to west, formed an excavation, or trench, about one hundred yards in length, narrow and shallow at its commencement, but widening and deepening all the way to the bottom, where it is several rods in width. On both shores

of the lake, the force of the water tore away large masses of earth, forced rocks out of their original bed, and, in various instances, laid bare the surface of extensive ledges of rock, which had been previously imbedded in earth; leaving them projecting a considerable distance beyond the line of the shore. These effects were most marked towards the northern end. About twenty rods from that end, an excavation, or trench, commences in the bottom of the lake, and continues to widen and deepen, until it coincides with the deep gulley at the outlet.

The surface of Mud Lake is at least 30 feet lower, in the opinion of the workmen, than before, and has not more than half of its original extent. The soft mud from the bottom of Long Lake, flowed into Mud Lake,* and took the place of the hard, tough mud, which originally formed its bed. So large was the supply, that Mud Lake is now shallow—having been filled up at the bottom, as well as cut off at the top by the abrasion of the torrent. I saw perhaps twenty of the trees, which had been left in it thirteen years before, standing up from its bottom, in various directions; and the length of their stems, above the water, indicated that the depth was moderate. Before the draining of Long Lake, Mud Lake had no lime; but large quantities of the white friable carbonate of lime were brought down and deposited within and around it, so as to render the manufacture of quick-lime a regular employment for several of the inhabitants.

Mr. Blodget, the proprietor of the mill destroyed in Barton, instituted a suit against some of the individuals employed in letting out the waters of Long Lake. In the course of the trial, the whole history of the event was brought to light. He laid his damages at 1000 dollars; but, *pendente lite*, compromised the matter for 100, on condition that each party should pay his own costs.

It was doubtless a favourable circumstance, that Long Lake was drained, while the country on Barton River was a wilderness. From the singular configuration of the adjacent ground, it is certain that its contents would sooner or later have been emptied into Mud Lake; and had the discharge been deferred, until the country had been well settled, the injury would have been incalculable. At the time when the event occurred no material injury was done, and an essential

* This lake was without a name, until this event procured for it this less poetical than appropriate designation.

service rendered the community; as the bed of the lake furnishes an advantageous site for a road leading to the country eastward of Glover, which the hills had previously rendered impracticable. Such a road had been seriously proposed when I was there; and my only objection to the measure lay in the fact, that, by effacing the vestiges of desolation, it would violate the rights of philosophical enquiry.

This event appears to confirm an opinion, extensively entertained in this country, respecting the changes which various parts of its surface have in former periods undergone. Valleys are here and there found, with streams of water passing through them, surrounded on all sides by high grounds, except a very narrow passage for the stream to enter, and another for it to escape; and in both, the whole appearance of the ground indicates that the high grounds actually met, in some former period; that the valley was originally a lake; and that its water was discharged by a water-fall. There is so much resemblance, between the bed of Long Lake and some of these places which I have examined, that I cannot doubt the correctness of this opinion. Had the waters of that lake been discharged two centuries earlier, its bed, and the gulley which it formed, would have been filled with a thrifty forest; and the evidence that it had ever been a lake, would have been no morre satisfactory than we now possess, that the places to which I have alluded were once filled with water. We now *know the fact*, however, that lakes may be suddenly and finally emptied, and their beds changed to fertile valleys, so as to lose, in no great length of time, all traces of the immediate action of water.

Several individuals, well acquainted with the country, informed me that the ground at one extremity of Lake Willoughby, which lies a few miles east of Barton, is formed like that at the northern extremity of Long Lake; and that its waters could be discharged with even less labour, than were those of the latter. Lake Willoughby is about seven miles long, about three miles wide in the broadest part, and very deep; and its waters, if thus discharged, must flow southeastward, through the valley of the Presumpsick, into the Connecticut. Could the discharge be achieved without too much hazard, it would be an incalculable advantage to a large extent of country; as a long range of towns in the neighbourhood of this lake, are separated from the Connecticut by a chain of pathless mountains, through which no

road can be formed, except over the emptied bed of Lake Willoughby, and are thus compelled to find their market down the valley of the Presumpsick; a fact which has almost entirely prevented their settlement.

After we had examined the bed of Long Lake, and the ravages which its waters had occasioned, as long and as minutely as our time would permit, we returned down the gulley, and arrived at our inn at 3 o'clock, where we sat down to a meal rendered welcome by laborious exercise and the fasting of ten hours. Immediately after, bidding four of my companions adieu, I rode down the river in company with the fifth, to the village of Barton. Our course was on the eastern bank of the gulley, and every step of the way I could witness the desolations of the torrent. Taking the whole excavation, for the twelve miles in which I followed it, it is the highest exhibition of the effects of physical force, instantaneously exerted, which I have yet seen.

At Barton, where my companion left me, I lodged at an inn near the outlet of *Belle Lake*, a sheet of water of the size of Long Lake, and in its situation and environs eminently romantic and beautiful. On its northern side, lofty perpendicular cliffs of white granite, said to be not less than 100 feet in height, project into the water. As seen from the southern shore, the front appeared columnar, and it was easy to fancy it a gigantic edifice, furnished with its appropriate suite of pillars and pilasters. The waters of the lake had that peculiar *crystalline* transparency, which belongs to the lakes of every granitic region. It could not be doubted also, that choice siliceous crystals might be found among the cliffs; but the solution of this point was reserved till my return. In the mean time, as a grammatical objection could be urged against the name *Belle Lac*, and as the good people in its vicinity might wholly have misconstrued the name *Beau Lake*, taking the epithet *beau* for a *noun* instead of an *adjective;* I concluded, for all these reasons united, to call it—THE CRYSTAL LAKE—a name which all other persons who please are at full liberty to adopt; but the propriety of which no one can fairly question, until, in a fine summer evening, near the hour of sun-set, when the gold of the clouds in the western horizon is all burnished anew, he walks enraptured along the shore of this lovely sheet of water.

In the morning I started in fine season for Lake Memphremagog; but, after a ride of eight miles, finding my horse

lame and my health feeble, and the road not only indifferent, but at a distance from the river's bank; and reflecting how far I was from home, in a country where no stage-coach could travel; I resolved, after a conflict of ten minutes, to turn about. This I most reluctantly did; and, after passing my inn, as well as the whole southern shore of the Crystal Lake, and casting many a look at the Giant's Castle, with a determination to atone for my existing neglect at some future period, I bade it adieu, and entered the wilderness, on my way to the valley of the Presumpsick.

I am, &c.

S. EDWARDS DWIGHT.

PROF. SILLIMAN.

ARTICLE III.—*Practical remarks on the shell marl region of the eastern parts of Virginia and Maryland, and upon the bituminous coal formation in Virginia and the contiguous region; extracted from a letter to the Editor, by* JAMES PIERCE.

IN a recent examination of the eastern part of Virginia and Maryland, I have ascertained that rich shell marl, of marine origin, and apparently in very extensive beds, is of frequent occurrence, from the ocean to the western termination of the district distinguished as alluvial on geological maps, a distance of 130 miles. It is found on the banks of James River, on the Appomattox to the vicinity of Petersburg, on York River and its branches, on various parts of the Rappahannoc, from Fredericksburg to the Chesapeake Bay, near the Potomac from its mouth to within eight miles of the City of Washington, and in numerous places between the Potomac and Patuxent. It occurs in many sections of the eastern shore of Maryland and Virginia, and is extensively diffused adjacent to saline waters, where, from the inefficacy of gypsum, it is most beneficial. This marl is often disclosed in sinking wells, and in ravines formed by minor water-courses, and exists in places sixty feet above the ocean. It resembles, in composition and useful properties, the calcareous marine deposits of New-Jersey, and the marl beds of North-Carolina, described by Professor Olmsted, in his valuable report

on the geology and mineralogy of that State. Its earthy base of clay and sand is rich in carbonate of lime, derived from the decomposition of shells, and in animal remains of ocean and land, relics of the antediluvian world, embracing in various stages of decay, numerous marine shells of extinct and existing species, gryphites, belemnites and bronchias, are remarked. Univalve shells, of the genera, nautilus, murex, turbo and dentalium, occur—and bivalves half a foot in diameter.

Teeth of the mammoth and shark, of unusual size, are found in marl beds, adjacent to York River. On the eastern shore of Maryland, large scallop shells, teeth conjectured to belong to the elephant, spines of large fish with vertebræ half a foot in diameter, entire skeletons of fish, and human bones, are reported as occurring in marl deposits.

Bones ascertained to belong to the human frame, have been preserved in diluvial calcareous beds, in Saxony, blended with bones from tropical regions.

Extensive beds of shells, supposed from description to be mostly valves of clams, connected by calcareous cement, exist in Maryland, at Marlborough, and other places west of the Chesapeake. Thick strata of this shell rock are penetrated in sinking wells, and are disclosed on the banks of creeks. When indurated by exposure, this stone is not easily broken. Large shells, of unascertained species, occur in valuable beds of marl, on Potomac Creek.

Although the great utility of marl, as a manure, has been long demonstrated in New-Jersey, by its practical results, yet the planters of the south, are not sensible of its value, or have too little enterprise to apply it extensively, but wherever the experiment has been made in Maryland and Virginia, its effects have been found decidedly beneficial. It has been advantageously applied in the cultivation of cotton, tobacco, wheat and indian corn. An intelligent planter, resident in the vicinity of York River, informed me that two years since he put a dressing of thirty loads of shell marl to the acre, on forty acres of sandy, exhausted ground, greatly improving the soil; a crop of wheat on this field the present year is among the most promising of any in that section of the state. A planter from the Rappahannoc mentioned a very valuable result in his vicinity in raising various crops from a light dressing of marl. A large produce per acre of good tobacco has been raised on the Potomac by marling worn out land.

The recent disclosure of marl in numerous places from Long Island to the Mississippi, verifies a suggestion I made in a communication on the marl of New-Jersey, published in Vol. VI. of the Journal of Science, that this valuable manure would probably be found throughout the southern sea board.

Enriched by clover crops, fostered by gypsum, and by marl dressings, the impoverished plantations of Virginia may be rendered very productive. A considerable part of the low country of Virginia, particularly in the district between the Rappahannoc and Potomac, called the Northern neck, originally presented a good soil that sustained forests of diversified timber; but when exhausted by tobacco and other crops, much of it was abandoned, and its barrenness confirmed by a growth almost exclusively pine.

In the Northern neck where marl abounds, the soil is in general a compact argillaceous loam; enriched, it would be well adapted for wheat and tobacco. In many of the eastern counties, sand predominates in the surface soil, generally resting on clay, and would be greatly benefitted by marl, enabling the planters to resume the cultivation of their old and profitable staple tobacco, little of which is now raised in Virginia, within 200 miles of the sea. Under the present system of agriculture, the soil will continue unproductive, and the planters be progressively impoverished. Wheat has been within a few years a precarious crop in many counties, from the ravages of the hessian fly and the chintz bugs; they often destroy whole crops. Many parts of the southern sea board are unhealthy for cattle, and not well adapted for profitable grazing. Though good crops of cotton have been produced the past summer on York and James river, and in several eastern and southern counties, yet it is apprehended that the cultivation of this plant from its precariousness in the latitude of Virginia, and its fast diminishing value, will afford but a forlorn hope to the planters. The summer of 1825 was peculiarly warm and protracted, and cotton might have been raised in the states north of the Ohio; but in ordinary seasons, a considerable portion of the boles will not ripen in Virginia or the western part of North-Carolina. Profitable cotton planting will be confined to the best soils of more southern climes. It is possible that the yellow cotton of China, from which nankeen cloth is fabricated, and which is described as a hardy plant, might be cultivated advantageously in Virginia. Clover and gypsum have been found adapted to the soil

in many of the eastern counties; few planters have tried the experiment in that part of the state, but many in the interior have resuscitated their worn-out lands by these efficient auxiliaries, and a rotation of crops. This system of agriculture is particularly well adapted for the argillaceous loam, highly coloured by oxide of iron, common in the middle counties. In Goochland county, an enterprising planter increased the productiveness of large tracts of worn-out land of this character, from 8 to 35 bushels of wheat to the acre, by turning in clover fostered by gypsum. I remarked that red argillaceous loam is the predominant soil of the rolling interior of the southern states, from Florida to Maryland, and generally covers the primitive rocks for 600 miles. It much resembles the soil formed by the disintegration of the red argillaceous sand stone, common in the valley of the Rariton, New-Jersey. But there are no traces of this rock in the red earth of the southern primitive range: the rocks below, mostly granite and gneiss, contain little iron. In its native state, this soil was strong and clothed with forests of oak. When exhausted by cropping, it is generally abandoned, and much of its subsequent growth is pine, which communicates no fertility to the earth.

In the southern states, too much is left to the discretion of overseers, who from indolence and ignorance are averse to innovations and attempts at agricultural improvements. Wherever slavery prevails, it is unfashionable for freemen to labour. In the middle and eastern counties of the southern states, not one planter in thirty personally performs any essential field work.

If the blacks of Virginia were passed off to more southern climes, and a white population labouring on small farms substituted, it would greatly add to the strength, respectability, and productiveness of the state.

The bituminous coal region of Virginia continues to be profitably explored, new shafts are sinking, and coal of an improved quality and in increased quantity raised.

From the pits south of James River, a million of bushels have been conveyed to Richmond the past year, a distance of 14 miles, at an expense of nine cents the bushel—the cost of raising is about four cents. A rail way can be constructed from the coal basin to Richmond, over a level or slightly inclining route; that would save forty thousand dollars annual expense of cartage, and give a fair profit to the stockhold-

ers. The coal is raised by machinery propelled by mules. A steam engine was erected at one of the pits, but abandoned, as the sulphuric acid of the water raised from the mine and used in the boiler, corroded and soon destroyed the iron. The coal in a few places approaches the surface, and quantities were formerly obtained with little labour, but it is now generally procured by sinking shafts from fifty to four hundred feet, at an expense of from seven thousand to twenty thousand dollars. A considerable proprietor is said to have realised, the past year, a profit of forty thousand dollars, from his coal pits.

Sand stone, loosely aggregated, mostly coarse grains of feldspar and quartz apparently from the veins of granite, is the predominant rock penetrated in sinking the shafts. Finer and more compact and micaceous sand stone occurs below. Adjacent to the coal the strata are more argillaceous and bituminous. The coal beds are from thirty to fifty feet in thickness, and appear inexhaustible. In the region west of the Alleghany mountains, and in England, strata of coal thicker than six feet rarely exist. In well ventilated shafts, accidents from the accumulation of carbonic acid and carburetted hydrogen gas seldom occur. Some instances of the combustion and explosion of the latter gas at the Richmond pits, were mentioned. Safety lamps have not been used, and a large proprietor of coal beds had not heard of the invention. The coal in pits and masses on the surface, are liable to spontaneous combustion, from the action of sulphur and iron connected with the coal. Several old pits adjacent to beds now worked, have been on fire many years; hot air and smoke incessantly issue from the shafts, from the crevices in the rocks, and from those in the earth; beds of coke will be the result.

The extent of the coal region has not been ascertained. Large bodies of coal have been recently found on the Appomattox, to the west of Petersburg, and it is probable the coal ranges into North Carolina. A bed of superior coal was lately disclosed, twenty miles west of Richmond, on the James river. North of that stream, about 400,000 bushels of coal were raised last year, and conveyed to Richmond through the medium of the canal, the expense of freight and toll being but three cents the bushel; but the coal is in general inferior to that raised south of the James river. Richmond, from its con-

tiguity to inexhaustible coal beds, and to the rapids of James river, is an excellent location for manufactories.

I noticed in the neighbourhood of Fredericksburg, under sand stone considerably resembling the rock at the Richmond coal beds, argillaceous strata, embracing vegetable impressions and small beds of coal. It is probable coal will be found in this vicinity; I observed similar indications in stone, quarried near the Potomac, 25 miles west of Washington.

The sand stone found on the Potomac below Washington, appears not an old formation. In boring at Alexandria for water, after passing through sand stone, described as resembling the ordinary rock of the Potomac, a stratum of clay like fuller's earth, was penetrated near three feet without finding its termination.

Art. IV.—*Meteorological Observations.* By Professor C. Dewey.

The importance of Meteorological Observations is generally acknowledged. They form the only data from which the laws according to which changes in the atmosphere take place, can be derived. Attention to them is continually increasing in our country. As the proper instruments are provided, and observations directed to be made at the different military posts in the United States, means are furnishing for a more extensive comparison. These means are increased by the observations made at the different literary institutions, and by many gentlemen in numerous places in our country. Various proposals have been lately made for the publication of a Meteorological Journal, which shall embody the results of the observations made over our extensive country. A vast many of the observations which have been published, and which are now making in our country and also in Europe, cannot lead to any satisfactory result, and form any good data for comparison of the results at different places, because there is *no uniformity in the times* at which the observations are made. The hours of observation have been nearly as different as the places have been numerous. There is such a difference in the temperature, for instance, at the different

hours of the day, that it is perfectly evident the results at one place cannot be compared for any valuable purpose, unless the temperature be noted at *the same hours* of the day. The relative temperature of places can be ascertained only by this uniformity, unless there be a series of observations so extensive as to lead to the conclusion, that at each place the observations must be made at certain hours, differing at different places, the mean of which will give the mean temperature of the place. This is so great and difficult a labour, that it will rarely be attempted. It is rendered the less necessary, if those thermometers be used, which give the *maximum and minimum* temperature. Omitting the consideration of observations on the barometer and hygrometer, or aerology, or the forms and changes of clouds, the fall of rain, snow, dew, &c. and all notice of the results already obtained, I propose to consider a few points necessary to be attended to, in order to make the observations with the thermometer particularly interesting and valuable.

1. The accuracy of the instrument. The points at which water freezes or boils, and the correctness of the graduation, are readily ascertained by methods well known. The thermometer may, however, be imperfect because the tube contains a portion of air. If the bore of the tube be relatively large, its destitution of air is proved by the column of quicksilver passing through it when the instrument is inverted. If the bore be quite small, this effect, however, will not take place, even if all the air is excluded, owing to greater friction in the smaller tube, in proportion to its diameter. In this case, it can be proved correct only by comparing the temperature it shows, with one known to be correct in this particular. This source of error is not liable to be great.

2. The elevation of the thermometer above the surface of the earth. The common elevation of the bulb, is about six feet from the ground. The thermometer should be exposed on the northern side of a building.

3. Protection of the thermometer from reflected caloric, by a screen placed before it, leaving the circulation of the air entirely free. The heat is often reflected from a road, or large spot of uncovered earth, or from rocks, so as to raise the mercury one or two degrees in a hot day above the temperature of the air, and that too when the reflecting surface is at the distance of several rods. Such a screen too will lessen the effect of radiation of caloric, by which, under a clear sky,

a thermometer shows a temperature from one to three or four degrees lower than that of the atmosphere.

4. The elevation of the place above the level of the ocean, and the distance too from the sea, should be ascertained, if possible. Where accuracy cannot be obtained, an approximation at least should be given with the results. The latitude of the place at least, and, if practicable, its longitude also, should be given.

5. If the *day and night* thermometers, or the *self-registering*, be used, it is necessary that the observers agree upon the hour at which *their day begins*. From *nine* in the evening to the same, will generally be found the most convenient, and the *meteorological* day will then embrace the greater portion of the natural day. From noon to noon will bring parts of two natural days into one observation. From sunrise to the same is objectionable, because the latitude affects the time of this appearance. Two observations only will be required in a day, one for the *maximum* and one for the *minimum* temperature. This kind of thermometer is not commonly made with the requisite care,—but it is very convenient, for the mean of a few years' observations must give *very nearly* the mean yearly temperature. Will not observers agree upon the first mentioned time for the commencement of their *meteorological* day?

6. If Farenheit's, or any similar thermometer be used, the number of daily observations and the time of making them should be the same. This is so obvious that no remark is necessary. Difference in latitude will affect the temperature in a slight degree indeed when the hours of observation are the same. But the results will be incomparably more valuable, than those now derived from observations made for a different number of times and at different hours of the day. I hope it will not be thought arrogant to propose *three observations* a day, and at the hours of *seven* A. M. and of *two* and *nine* P. M. through the year*. For these hours there are two reasons.

1. It is believed more observations have been made at these hours than at any other set of hours, both in our country and in Europe.

* In the year 1824, the mean of the temperature at sunrise and sunset through the year, was very nearly *three degrees* lower than the mean of the temperature at seven A. M. and two and nine P. M. and there can be little doubt that in this latitude at least, the temperature at sunrise and sunset must be below the mean temperature of the year.

2. From an attempt made a few years since to ascertain the mean temperature of the day, the mean of the temperature at these three hours was found to give it very nearly. To effect this I took the temperature every hour through the day and night for several successive days, and at different seasons of the year. The *mean* of the twenty-four daily observations was nearly the same as the mean of the temperature at the *three* hours just mentioned. The observations and results were published in the Memoirs of the American Academy of Arts and Sciences, Vol. IV. Part 2. By consulting that paper, it will be seen also that the mean temperature of sunrise and sunset is near the mean of the twenty-four observations in a day. But for the year, this mean is seen in the note to be too low. It is readily acknowledged, that the results obtained in this way, are only an approximation. Still it is believed that it is a nearer approximation than has been obtained on this subject before. It is obtained by so much labour in this case, that the observations will not *often* be repeated.

It is hoped that the importance of uniformity will induce observers to adopt the above hours, or to take the observations only twice in the day, viz. at the rising and setting of the sun. It is certain at least that so far as the temperature is concerned, a Meteorological Journal will not possess much utility until there be uniformity in the time and number of the observations.

Remarks by the Editor.

The important subject of meteorological observations is beginning to command an increasing share of public attention in the United States. It appears by a circular signed by S. De Witt, vice-chancellor of the university of New-York, that the regents have adopted a resolution to furnish each of the academies incorporated by that board, with a thermometer and a rain gauge, for the purpose of obtaining accurate statements of the temperature and of the weather, in a state, interesting both on account of its geographical situation and extent. These institutions (about fifty in number, besides six colleges) are required to make annual returns; a summary of which will be published with the journals of the legislature, and will thus be preserved among the public documents. A system of regulations has also been drawn up and published

under the authority of the vice-chancellor, giving precise directions for the use of the instruments, and for making meteorological observations with correctness. These directions have evidently been digested with great care, and after mature consideration, and should they be generally adopted, they can hardly fail of producing the desired result. The ideas are, in general, similar to those of Professor Dewey, as stated in the preceding paper; the remarks are too extensive to admit of insertion here; as, however, the method proposed for obtaining the mean state of the winds, and the mean temperature, is peculiar, we will copy that part from the printed directions.

"Count the number of times that each point of the compass appears in the A. M. and P. M. columns, under the caption of *Winds*, and the half thereof must be considered as the whole number of days on which that wind has prevailed during the month; and enter in a convenient place, the number of days thus found, on which the wind has prevailed from each of the eight half quarters of the compass.

Do the same with the entries of *fair* and *cloudy*, under the caption of *Weather*, counting the entries of *snow* and *rain* among the *cloudy*. To these subjoin the number of days on which it has rained or snowed, counted in the same manner, and the quantity shown by the gauge; also the warmest and coldest days shown by the mean, the highest and lowest degree of the thermometer, and the prevailing wind of the month.

Observations by the thermometer must be made every morning, when it shows the lowest degree, every afternoon when it shows the highest degree, and every evening an hour after sun-set. The lowest degree, or coldest weather, is supposed to occur generally between the commencement of day-light and sun-rise, and the highest degree or warmest weather, between two and four o'clock in the afternoon. The degrees are to be taken from Farenheit's scale.

At the end of the 14th of February, and the 15th of every other month, add together the numbers in the column of mean temperature, divide the sum by the number of days, and set down the quotient underneath, for the mean of the *first half of the month*. Do the same for the other days at the end of the month, and set down the quotient at the bottom of the column for the mean of the *second half of the month;* add

this to the first mean, and divide the sum by 2, for the mean of the *whole month*—which enter accordingly.

As the method which is now prescribed for making observations by the thermometer, and deducing their results, differs from the usual practice, it is proper to give the reasons for its adoption.

The most obvious method for finding the mean temperature of the day is, to make observations every hour, and divide the sum of the observations by their number. But this cannot be prescribed, on account of the unremitted attention it would require. Another is to ascertain the extreme points to which the thermometer rises and falls on each day, and to take it for granted, that if the observations were made at every hour, from one extreme to the other, they would give a series of numbers in arithmetical progression, the sum of which, divided by the number of observations, or its equal, half the sum of the extremes, would then give the mean. For example, suppose the lowest degree of the thermometer to be 30, at 6 o'clock in the morning of any day, and the highest degree 48, at 3 o'clock in the afternoon; these, with the eight intermediate hours, will give a series of 10 terms, 30 and 48 being the extremes: then

$$\frac{\overline{30+48}\times 10}{2} = 390,$$ the series; this, divided by 10, the number of observations, will give

$$\frac{30+48}{2}$$ 39 for the mean, that is, half the sum of the extremes.

Again, suppose on the morning of the next day, the extreme depression to be 32 degrees, then, for the time between the afternoon observation and that of the next morning we have 48 and 32 for the extremes, half the sum of which, 40, will be the mean temperature of that portion of time. This, added to 39, the mean of the preceding part of the day, gives 79, the half of which is 39,5, the mean of the whole day, which is here considered as comprising the time from the morning observation of the day for which the mean is sought, to the morning observation of the next day. The rule may be reduced to this formula: *To the morning observation and twice the afternoon observation, add the morning observation of the next day, and divide the sum by 4*; thus

$$\frac{30+96+32}{4} = 39{,}5.$$

If the change be such as here assumed, that is, strictly in arithmetical progression, the mean thus deduced must be true with mathematical precision; but it is not pretended that it will be perfectly so; indeed we know that the ratio is generally less, in so much of that part of the series which extends from the extreme of the afternoon to the extreme of the next morning, as is occupied by the night. It will therefore be proper to divide this series into two, by an intermediate observation, which is directed to be made an hour after sunset; whether this be the most eligible time may be considered as left for examination. We shall then have three series divided from each other, by the morning, afternoon and evening observations; to find the mean of which, *add the morning observation, twice the afternoon observation, and twice the evening observation, to the next morning observation, and divide the sum by* 6. This it is believed will give an approximation to the truth, as near as can be obtained by ordinary observations, and a mean sufficiently correct for every contemplated purpose."

As a medium by which to bring before the public, the result of these extensive observations, Mr. Horatio Gates Spafford proposes to publish a State Meteorological Journal, prepared from monthly reports from every county. This will evidently be a very useful undertaking, and we cannot doubt that Mr. Spafford will execute it with care and accuracy.

It would be happy if barometrical observations could be added to those made with the thermometer and rain gauge, and perhaps the regents may hereafter find it convenient to furnish the different institutions with this important instrument. The expense, we are aware, would be considerable, but we trust that this will not be regarded, in a great, opulent, and enlighted state like New-York. An effort is judiciously makingt o induce good observers in other states and countries, to register their observations, upon a plan similar to that proposed by Vice Chancellor Dewitt, and for that purpose his circular is transmitted to many individuals, from whom it is to be hoped, that important aid may be derived.

It is but justice to recal to the public recollection the fact, that an interesting paper was communicated, by Professor John Griscom, to the Literary and Philosophical Society of New-York, in December, 1814—entitled "Hints relative to

the most eligible method of conducting Meteorological Observations." This excellent paper contains all that is most material to be done on this subject, although the recent directions from the university have given additional precision.

Meteorological observations are made, apparently with attention, by Samuel Williams, at Chilicothe, Ohio, and the detail for one year, with the temperature for morning, noon and night, of each day, has reached us through Niles's Register. It is very desirable to know the state of the climate in the Western States, where, as yet, there have been fewer accurate observations than in the Eastern and Atlantic States, and we trust we may look to Mr. Williams for interesting results.

Meteorological Registers are often forwarded to us through the medium of newspapers printed in particular places, thus evincing that there is considerable attention paid to this subject; and it would be very desirable that the ideas of Prof. Dewey should be adopted, so far at least as to induce observers to agree on uniform periods and modes of making and recording the observations now so incongruously made, that they may in this manner be brought to one standard.

Art. V.—*On Fuel.** *Communicated for the American Journal of Science, &c. By* Elisha North, M. D. *of New-London, Conn.*

Every kind of fuel may be arranged into two classes.

1st. That which consists of bituminous or hydrogenous matter, and carbonaceous matter. Extraneous matters, whether hurtful, or not, are rejected in making the classification.

Some chemists think that bituminous and hydrogenous matter are very much alike, or nearly the same—therefore

* The writer wishes respectfully to acknowledge the obligations he is under to Professor Silliman, for having furnished him with Dr. McCulloch's Essay on Peat; and also for his candid hints in his private letter, on the subject of fuel. The reader will perceive from Prof. Silliman's remarks on Pennsylvania coal, already published, that there is some difference of opinion between him and the present writer. This, however, is not very unusual, on a philosophical subject, that is liable to be influenced by the operation of one's

each term is used. It is not proposed to give an accurate analysis of the various sorts of fuel, or an accurate account of combustion.

2d. That which consists almost entirely of charcoal, carbon, or carbonaceous matter.

The first class embraces every sort of firewood, including peat-wood, and every kind of bituminous coal. The reader will presently perceive why the name of peat-wood is used.

The second class comprehends charcoal, whether made from peat, or any other kind of firewood, coke, and anthracitic coal, such as Rhode Island, Lehigh, Schuylkill, &c.

Another division of fuel might be made, viz: one class might be made to comprehend every sort which grows in the air, and upon, and just within the surface of this earth: and another class to include that which grows in the water, underneath, and sometimes far beneath the said surface. The reason for this division will presently appear.

Peat may be regarded as a sort of firewood, for it possesses, while burning, all the more essential qualities of any other sort of firewood. There are also two, if not more, sorts or species of peat, besides their varieties, and the present writer has ascertained, or he is decidedly of opinion, that peat is living, organized matter, which grows in water, giving a resem-

taste, habits, interest, and disposition to follow the fashion. Every one, in an affair of science, has, however, a right modestly to propose his opinions, and the reader or hearer has an equal right to decide with regard to their correctness.

Dr. North's opinions on the subject of the effect of different kinds of fuel on the apartments, appearing to me not only somewhat novel, but unsupported by, if not contrary to, facts, ascertained by experiment, I threw out those suggestions, along with others, in a private letter addressed to him. As, however, he is still inclined to submit his views to the scientific public, they will judge how far his opinions are tenable. His hints with regard to the origin of coal from peat, can hardly be judged of correctly, without the evidence, which he has not stated; and it may strike common readers as an unnecessary departure from the established use of language, to call peat "*wood*," notwithstanding that it is composed in a great measure of vegetable fibre, or of its remains; and chemists may probably object to the application of the word "*bituminous*," to so many bodies which scarcely contain that compound, although they contain its elements, and particularly hydrogen, to which, without doubt, bitumen owes its peculiar combustibility. There is no doubt that peat is a very valuable fuel, and all will agree that Dr. North is performing an important service, by attempting to excite the attention of his countrymen, to this neglected but valuable resource; the more valuable, because it is so extensively diffused and so easily accessible. EDITOR.

May 3, 1828.

blance to wood in its power of growing.* Peat is known to connect or entangle within itself, and also to preserve by an antiseptic power, such dead vegetable matters as may have fallen into it. Most of those vegetable remains, have previously grown in the air, upon its surface. Peat likewise contains the roots of such living vegetables as have grown with it, and if the peat has grown in impure or feculent water, it may contain the impurities of such water, and these may exist to such a degree, as to render the peat useless for fuel. These impurities may be either earthy, metallic, or saline. There is found in some peat basins, or marshes, a spongy spurious kind of peat. This, when dried, is too light to be profitable.

The evidence that peat grows, or increases in bulk, and that rapidly too, when compared with many sorts of trees, is founded on observation, and is of the same nature, as that which regards the growth of trees. This evidence, when attended to, is obvious to the meanest capacity. The writer has known peat to grow upon the bottom, and at a considerable distance from the surface of a common pond. In this situation the remains of other vegetables could not possibly fall into it. Other vegetable roots however, grew in, or with the peat, and this, as the writer believes, is always the case.

The peculiar manner of the organization of peat, or whether it be a vegetable, or semi-vegetable organization, or how many species there may be, is unknown, at least, to the present writer. But green or fresh peat, appears to be a pulpy, elastic, slippery, dark coloured matter, if the peat be of the true and useful sort. But if spurious, it is fibrous and of a lighter colour. Both kinds contain other vegetable roots, if not other matters. The writer has now before him, a piece of

* Those who may think it injudicious, to apply the name wood, to that substance which has been called by the various names of peat, turf, tug, and firing, are reminded, in justification, that Dr. M'Cullock may be cited as a very respectable authority for so doing, for he calls bituminous fuel, lignite, a similar name, to distinguish it from inferior peat. Every organised substance which is used for fuel, the writer contends, may, without great impropriety, be called firewood. And on the other hand, such fuel as has become disorganized or altered in its nature, may be called the remains of firewood. These remains may be a natural production, as the various kinds of coal, or an artificial one, as charcoal or charred peat. Besides, so many persons are under the influence of names, that it may be justifiable to use the term peat-wood, as a laudable means of expediting the usefulness of the thing itself. Dr. M'Cullock's interesting essay on the natural history, and chemical analysis ~~of peat~~, published in the Edinburgh Philosophical Journal, Vol. II. 1825, has been furnished the writer, since the above essay was written.

young peat dried, of the true sort, which is known to have grown within the last six years. It is of a lighter brown colour, and less dense, and heavy, than old peat of the best kind.

The ashes of the various kinds of peat, are of different colours—but those of the best sort, are of a reddish brown, and considerably heavy. A given quantity of good peat, gives more ashes in bulk, and also in value, if first used for retaining heat in a fireplace, and afterwards for manure, than an equal quantity of any other fuel.

Coal beds, are conjectured by some, and believed by the present writer, to be the remains of peat, and a few other vegetables. These articles are presumed to be changed by a natural charring, or coaling process, into the various and different kinds of coal which have been found.

Common firewood, before it is cut, is known to be living, organized matter, which contains charcoal, and the hydrogenous or bituminous principle. The latter, as is well known, can be made to disappear by the smothering and evaporating, or partial combustion process, which is used in making charcoal.

The various sorts of firewood, which have grown in the open air, contain fewer hurtful extraneous matters, than the various kinds of peat and coal. But peat and coal, more especially the former, which contain no foreign hurtful ingredients, are, or may be, more highly charged with the bituminous or hydrogenous principle, than is the case, with the more common sorts of wood. This is probably occasioned by the peat having grown in water, which is known to contain the hydrogenous principle in great abundance. Peat, and coal, of such a quality, as has just been considered, makes a more uniform, mild, and pleasant heat, if not a better fire, than ordinary wood.

Bituminous fuel, kindles and burns at a low temperature, and is attended with much flame, soot, smoke, dust, and many ashes, but has, notwithstanding its inconveniences, been used for producing a genial warmth, in every age and country.

Carboneous fuel kindles and burns at a high temperature, and is attended with little flame, smoke, and few ashes. This sort of fuel has hitherto been preferred in the arts only, where a vehement heat is required. But justice and candour make it necessary to say, that bituminous fuel, has almost every where been the cheapest.

But of late, it is contended in Philadelphia and New-York, that anthracitic coal, which is remarkably stubborn and durable, can be made both a cheaper and better fuel than any other, not only in the arts, but for domestic purposes. The question whether such is proper to produce a pleasant and wholesome temperature, is the only one now to be discussed. And it is thought this question is an important one, as the well being, in a greater or less degree, of numbers of the present race, and of posterity, is probably involved in its correct decision. A certain quantity of heat, furnished either by the sun or fuel, is obviously indispensable. But from this it does not follow, that too much heat, or heat of that sort which may be unsuitable, would not be hurtful. Hence the inquiry may very properly be made, whether the vehement heat, or as the case may be, modified caloric, or a carbonaceous state of air, produced by anthracitic or charcoal fires, if generally used, may not diminish that vigour and hardihood of the human race, which is so much wanted in a world like this. What is meant by a carbonaceous state of air, will be explained by and by in a note.

Posterity will probably be able to settle this question, from experiments that are now making upon a large scale. Are those who are exposed to the influence of charcoal, and other carbonic fires in the arts, and in Pennsylvania, and a few other places, as healthy and hardy as other people? The solution of this question would help to settle the other.

*Whatever the cause may be, there should be no doubt about the fact, that bituminous fuel, burnt in an open fire place, which is made of brick or stone, produces by its radiant heat, light and temperature, more pleasant and comfortable sensations, than is occasioned by any other sort of artificial heat.**

* The writer begs leave to suggest, at least in a note, his ideas of what may be the cause of the above fact. When an increase of temperature is artificially produced, in a portion of the atmosphere, there may be not only an increased quantity of caloric, but a small quantity of the materials which furnish the caloric, in combination with it, or in union with oxygen, or both. Thus carbonic fires, or carbonized, or cast-iron stoves, may diffuse carbonaceous matter through a portion of air. The scorching of mites or animalcules by such stoves, is a very inadequate cause to account for their oppressive effects. And bituminous fires may diffuse bituminous matters through another portion. And the effects of those different portions of atmosphere thus differently charged upon animal bodies, are believed to be different, *independent of the degrees of heat.* For it is a notorious fact, that a carbonaceous state of air by close confinement, has often been rendered sufficiently poisonous to extinguish human life, and hot carbonic acid gas is believed to be different from that which is cold. It is also believed that in the general

How it may be with regard to the degree in which the combustion just mentioned, may be more wholesome, is left for others to determine. But one who furnishes that sort of pleasure or comfort, should receive a higher commendation, if not a greater reward from his guests, than one who warms them with iron stoves, carbonic fires, or heated air only. Considerations of this sort should have an influence in regulating the different value of the various kinds of fuel, and come into consideration with regard to the different modes of burning them. Those who direct the employment of capital, and labour in procuring fuel to supply the public wants, should procure every sort in proper quantity, and each of these sorts should be used for the purpose for which it is best calculated.

Whenever the writer treats of peat, which is not so universally known as most of the other sorts of fuel, it is his determination not to give it a higher character than it deserves. The opinion he has formed respecting its utility, has been

operations of nature, caloric has a two-fold effect upon the atmosphere; one is to increase its temperature, the other is to diffuse bituminous or hydrogenous matter through said atmosphere, for the benefit of animals and vegetables. This is rendered highly probable by the circumstance, that the combined operation of caloric and oxygen, decomposes hydrogenous and bituminous matter more easily, i. e. at a lower temperature, than is the case with the more stubborn carbon, or carbonaceous matter. The reader will now understand why the term carbonaceous state of air has been used. That a bituminous state of air is proper to come in close contact with animal bodies, is rendered highly probable by the circumstance, that animals in general, as well as man, are clothed in bituminous matter, or matter which contains that principle, if hair, wool and feathers may be regarded as clothing. As bituminous and carbonaceous states of air are now much in use, sedentary people should understand this subject if others do not, because they live during the winter season, mostly in one or other of those kinds of air. Those who may think that the ideas expressed in this note and text, are too theoretical, are reminded that medical men are daily in the habit of acting for the benefit of the human body, upon evidence which is not stronger. This evidence arises from observations made upon one's self, confirmed by the testimony of others, and from one's general knowledge of the laws of nature. The testimony, however, of different persons, is different. Some complain more of headache and other oppressive effects from carbonic fires, than others. Negative testimony, however, weighs less than that which is positive. Should the attempt to explain the reason why some fires are more comfortable than others, fail to be satisfactory, for no chemical experiments on the subject have been made by the writer; he feels confident respecting the existence of the facts attempted to be explained. By the by, chemical science is often too imperfect to explain physiological facts. The writer has paid much attention to the difference of sensation produced on his own body, by different fires, and he believes the testimony of others when their attention is turned toward the subject, will ultimately confirm that which he has given. The writer is more solicitous to establish such a medical and physiological fact, than a chemical theory, because the former is of more importance to human comfort, if not health, than the latter.

confirmed by judicious and candid persons, with whom he has conversed, who have been practically and thoroughly acquainted with it: and this sort of knowledge, is, for a variety of reasons, especially needed to form a correct opinion on this subject. The present writer believes, judging from much experience, that peat of the best quality, if used for producing a genial and pleasant temperature, in common moderate winter weather, is the best fuel which the earth produces, unless an exception be made, in favour of a *very few species of trees equally well prepared.*

To make this opinion, however, entirely correct, the subject must be viewed philosophically, and rationally, without reference to habit, fashion, prejudice, and wrong asseverations. It is not expected however, that those who are unreasonably fastidious, either from a natural propensity, or wrong education, will agree to the correctness of the above opinion, on account of its ashes, dustiness and odour.* The inconveniences, however, so far as they are substantial, arising from that source, are very easily and cheaply remedied, for the dust of peat is not adhesive. And those who are nice, even to a fault, may find it useful to mix with other fuel. If false opinions exist extensively, with regard to such necessary articles as the various sorts of fuel, it would seem desirable that they should be corrected.

A common individual, however, can do little more than throw in his mite for such a purpose, or in other words, use his influence, to be aided, as he hopes, by that powerful engine, the public press.

As evidence that public opinion, in some places, is in favour of peat, it may be mentioned that Citizen Ribaucourt, published a regular treatise on the subject, by order of the French government, in the eleventh year of the republic. In this treatise, he says, 10,000 persons are annually employed in

* Dr. M'Cullock says, such odour is occasioned by an essential oil. That odour, may, therefore be useful for the lungs and head. Indeed, there is a traditional opinion among the Irish people, that those who use peat fires are less liable to consumption, than others. Dr. M'Cullock, when he gives his opinion with regard to the general usefulness of peat, of a particular sort, says, "It is so compact, as to afford a flaming fuel, nearly equal to the inferior kinds of coal." That opinion may be correct, taken in a very general sense. But the present writer contends, that *assorted peat of the best kind*, is fully equal to the best kind of bituminous coal, and for some purposes better. And some of it he knows will sink in water. It must therefore be more valuable per cord, than other wood, especially if we take into consideration its great utility for mixing with the latter kind of fuel.

preparing, and transporting peat, from one peat basin or marsh, upon the lesser branch of the river Loire, in the north-west part of France. This peat bed cannot be a great distance from the city of Nantes, where much peat is burnt, or even from the city of Paris. Those who may suppose peat-wood to be used in France from necessity, are informed that in Paris, common firewood is said not to be dearer than in the city of New-York.

The labour of preparing peat-wood for fuel, (unless it can be cut by powerful machinery,) must always be somewhat greater, as the writer believes, although others think differently, than that for preparing other wood, because it must be cut smaller, and afterwards seasoned. It shrinks much in seasoning. Dried peat is in small pieces, and liable to break, which makes it less convenient to transport than common firewood. But as large masses of peat exist, and grow, in a small compass or space, and sometimes near navigable water, it possesses, in that respect, a very great advantage over common firewood. For, by a short canal, or rail-way, the expense of carting may be saved, and that expense is known to be often very great, for ordinary wood.

Can the bituminous principle be usefully supplied to anthracitic coal-fires, by the agency of peat? Can peat be made useful in this country for producing gas lights? Can it be charred to profit, in any part of this country? What must be the value of firewood standing on farms, before good peat, if existing on said farms, can be made profitable to their owners? To this last question, the writer can give an answer, which is, that common wood must be worth about one dollar per cord, while standing.

From the data above given, the reflecting reader will perceive, that considering the diminution of the more usual sorts of firewood, peat, or peat-wood, may be made useful, even at the present age, to the owners of many farms, and to their more immediate neighbours. Indeed peat is now in actual use, in many parts of this country, as well as in Europe. But it is believed that even in Europe, it is not in use, so much as it ought to be. Such a reader will also perceive that the combined exertions of numbers, with the aid of capital, calculation, and labour, might make peat-wood much cheaper in some of our markets, than any other sort of wood, and probably cheaper than any kind of coal. He will also perceive that individual exertions, uncombined, are not sufficiently

powerful to effect such an object. Because, he who wants to buy fuel, may not find motives sufficient to encourage the exertions and labour of individuals, by paying the same, or nearly the same price for peat, as for other wood, unless it can be proved to be equally valuable in every point of view which can be taken of it, whereas, the fact is, that it is only equally valuable, for specific purposes, with a very few exceptions. The same is true respecting coal. Hence it is evident, that without combined exertions, the public market cannot be supplied with this valuable fuel, at the present, if it can at any future time.

For similar reasons, individual exertions uncombined, have never been sufficient in any country, to force even coal into the market, beyond the immediate vicinity of coal mines.*

Is it not desirable that the public should have the benefits which would result from the introduction of a cheap fuel into the market? Cannot the combined exertions of individuals in this enlightened age of improvements be had? especially when it is the fashion to increase power, by similar combinations, for other public purposes. The benefits of Lehigh and Schuylkill coal, have recently been thus obtained, and one improvement in society often gives rise to another. The writer therefore wishes to embrace this opportunity to impress strongly upon the consideration of those who may have capital, and who may wish to employ it upon some of the raw materials of our country, whether by means of the late improvements which have been made in rail-ways, loco-motive steam engines, canals, and tow-boats, peat-wood may not be removed from some of the basins or cavities in which it grows, to some of our cities, and give a profit to those who may engage in such an enterprise. The present writer believes that such an undertaking, might be made to succeed in some parts of this country, even at the present time. He believes also, that bituminous fuel is, *ceteris paribus*, for most purposes, upon the whole view of the ease, the best, and that too, for the same reason that he believes a manageable horse to be best. And he presumes that such will ultimately be the general opinion, where stowage is easy. But the difference among the various kinds of fuel is not so obvious as to prevent a difference of opinion on this subject. Bituminous fuel is also the most abundant upon this earth, and nearer to

* Can this be true of England, where scarcely any other fuel is known?—EDITOR.

where it is wanted than any other, and probably the most easily obtained. There may be exceptions, however, to so very general a rule.

Addenda.

The reading of Dr. McCulloch's valuable essay, since the preceding was written, has made these addenda necessary. Dr. McCulloch adopts the common opinion, that peat is decomposed or dead vegetable matter, and that the whole of such matter always originates from vegetables growing on its surface. He has given full botanical catalogues of the plants which he supposes contribute to the formation of the different kinds of peat.

For the sake of a text to make remarks upon, the following passages are selected from different parts of the essay:—He says, "As the increase of peat keeps pace with the plants from which it is formed, it is evident that the cessation of the one is implied in that of the other, with the exception of transported peat, which does not directly depend upon the same cause. That it may be renovated after cutting, it is necessary that the process of vegetation be renewed, where it has been thus suspended." It is evident, from the tenor of the essay, that the Doctor means the process of vegetation among the various plants only, which shoot their roots into the peaty matter.

Again: "The time required for the production of a given depth of peat, has been a frequent subject of inquiry. In some cases its growth has been so rapid as to be sensible to the observation of individuals, but in general it has been necessary to have recourse to evidence, founded on circumstances involving a much longer period of time than human life." Again: "It has been remarked on the continent of Europe, that cavities of seven feet in depth, made by cutting peat for fuel, have been filled up with it, in the short space of thirty years." Favourable circumstances are however said to be necessary for such a result. The present writer, from a comparative mode of judging, thinks such a cavity in our climate, under favourable circumstances, would fill up in less time than thirty years. But then he doubts whether the peat would sooner become sufficiently solid, bituminous and woody, to be profitable for fuel. The peaty matter itself grows, as well as the plants whose roots are found in it. Water is need-

ed for the growth of the peat, as well as for that of the vegetables whose roots penetrate it.

The best agricultural writers believe that one hundred years are needed for the accumulation of one inch in depth of vegetable mould, in a forest, upon dry land. This vegetable mould is the production of decomposed or dead vegetables. The difference of an inch in depth, of the remains of vegetation, accumulated on dry land, in an hundred years, and the accumulation of seven feet in depth, of similar decayed matter, in the short space of thirty years, in a swamp, is too great to be accounted for, upon similar principles, even admitting the circumstances in the two cases to be in favour of the swamp. But the reverse of this last position, notwithstanding the general opinion, is believed to be the fact.

The reader will at once perceive, that to make the ratio of dead vegetable matter equal in depth in a swamp, and on a hill, that the enormous depth of nearly twenty-three feet, instead of one inch, would be the produce of decayed vegetable matter in one hundred years. The proportion is as 1 to 276.

Besides, soft peat, even when no vegetable roots are visible, cuts and retains its shape like organized matter, and in seasoning like such matter, it becomes not only solid but woody. It also, when exposed a long time to the weather, appears like other rotten wood, having probably in that case, undergone a similar decomposition.

Chemical analysis also shows a great analogy between organized wood and peaty matter. Peat resembles, in another point of view, both common wood and coal. There are all sorts of peat, good, bad, and indifferent. Such also is the case with common fire-wood, and also with coal, which is regarded by the present writer as the remains of peat.

The following facts are mentioned as having a bearing upon the main question. When an excavation is made in cutting peat, the water oozes in on every side. Now when such excavation is made six or seven feet deep, the pressure of the adjoining water alone, which generally surrounds such cavity, must be immensely great, too great to be counteracted by that which Doctor McCulloch calls a semi-fluid paste. The power which counteracts this pressure may be a spongy or semi-spongy organization. For other kinds of soft unorganized matter, as soft sand, or semi-fluid earth, would at once yield to such force, and bury the workmen.

There are two modes of cutting peat, but the one in use upon Block Island, in this country, is much better than any other which has come to the knowledge of the writer. It does not, however, come within his plan at present, to describe such mode.

Again, in an artificial cavity, in a peat-bed which had been in existence six years, the writer has seen peaty matter growing, or rising even above the surface of the water. This was in a dry time in the month of August. A few other water plants, and but a few, were seen growing in said peaty matter. This last matter was soft, and appeared upon examination to be spongy, or semi-spongy, *and in the writer's opinion it was organized.* The life of peat would probaby be destroyed by permanent drainage, and its quality for fuel injured.

As the associations of the reader, as well as those of Doctor McCulloch, are expected to be against the doctrine of the organization of peat, the writer has thought it needful to fortify the doctrine, both by arguments and facts. He is aware that this management may be tedious to some of his readers, but he hopes to experience their candour and indulgence, as the object of the investigation is the discovery and propagation of truth.

Did it come within the writer's plan to give the natural history of peat, or peat-wood, he could easily show that there is no such variety as that which Doctor McCulloch calls transported peat,because the peaty matter grows where it is found.

Before the writer takes leave of the reader, he wishes to say, in this public manner, to his particular friends, that he is not sanguine with regard to his power of extending the usefulness of peat, for the history of other things shows the great difficulty of such an undertaking. This difficulty is well exemplified in the history of the common potatoe, which shows the great influence of authority and fashion in human affairs. "The introduction of this valuable plant, received for more than two centuries," says a popular writer, an unexampled opposition from vulgar prejudice, which all the philosophy of the age was unable to dissipate, until Louis XV. wore a bunch of the flowers of the potatoe, in the midst of his court, on a day of festivity, *and the people then for the first time, obsequiously acknowledged its utility, and began to express their astonishment at the apathy which had so long prevailed, with regard to its general cultivation,"* &c.

The history of another natural production is equally curious, namely, that of the tobacco plant. This plant was once an insignificant production of a little island, but has since succeeded in diffusing itself through every climate, and by its fascinating powers, it has also succeeded in subjecting many of the inhabitants of every portion of the earth, to its dominion. And yet it is believed even by many of those who use it, that the world would be better without than with it.

New-London, April, 1826.

ART. VI.—*Anthracite Coal of Rhode-Island—remarks upon its properties and economical uses: with an additional notice of the anthracites of Pennsylvania, &c.;* by the Editor.* Read before the Connecticut Academy of Arts and Sciences.

IN the last number of this Journal, (Vol. X. p. 331,) some remarks, drawn principally from observation and experience, were inserted, relative to the anthracite coal of Pennsylvania. The additional experience of two or three months, has confirmed the views then expressed, only a few slight corrections or additions having become necessary.

In that paper, it was remarked: "I am not able, at present, to say any thing of much importance, as to the Rhode-Island anthracite. A quantity, which had been promised for comparative experiments, not having arrived, I have not been able to compare it, with the Pennsylvania anthracite, except as regards the gas. I hope to make these trials before the season is through, and cannot doubt, that the Rhode-Island coal will prove an important addition to our national resources, especially with the aid of the practical knowledge, which has now been so extensively obtained, with respect to the use of the anthracites."

* I wish it to be understood, that my remarks and opinions, respecting the Rhode-Island coal, as a fuel valuable in domestic economy and the arts, are derived *entirely* from my experience with a quantity sent me from the mines. I am assured that it was a fair specimen of that which is now raised and offered to the public. I vouch for nothing more than a correct report of the facts which, *with views wholly disinterested,* I have observed, while using, and performing experiments upon the materials, which were placed in my hands.

The engagement thus made, I am now, in some measure, prepared to fulfil. A sufficient quantity of the Rhode-Island anthracite, immediately from the mines, having been placed at my disposal, I have made, with this substance, experiments, similar to those performed on the coal of the middle regions of Pennsylvania, and have used it, exclusively, in the hall stove, for eighteen days.

From the year 1802 to 1813, I was frequently at Newport, and in 1807 and 1808, passed some of the summer months there. In company with Col. George Gibbs, who had, not long before, imported his splendid cabinet from Europe, and deposited it temporarily in his native town, I made frequent excursions through the island, for the purpose of mineralogical and geological observations. During these little journies, through one of the most delightful regions in America, I became first acquainted with the existence and localities of the anthracite of Rhode-Island.

In the course of the two or three years immediately subsequent, the mines were opened and wrought to such an extent, as to evince the practicability of supplying large quantities of this mineral fuel. But the country was then ill informed as to the nature and uses of the anthracite coal. It was known, in general, that a similar coal was found and advantageously used in Ireland, Pennsylvania, &c.; but people were repelled by the apparent incombustibility of this coal; they could not make it burn in the usual way in which wood is burned in a common fire place, and it was hastily and impatiently laid aside, as nearly or quite useless, except that a few manufacturers of iron, continued to use it as long as it could be obtained.

This precipitancy in abandoning this coal appears the more extraordinary, as an excellent account of the Rhode-Island anthracite was published by Dr. William Meade, in a pamphlet, an abstract of the most important parts of which appeared in Dr. Bruce's Mineralogical Journal in 1810. In this account, its real properties are fairly and faithfully described, and its numerous and important uses are fully pointed out. It appears now very strange, that Dr. Meade's account should have failed to produce conviction, in the public mind, which seems not to have been as yet sufficiently informed on this subject, to receive the truth. The Rhode-Island coal, although its exploration was now sustained by Boston capital, (always bountifully and promptly bestowed

on objects deemed to be both feasible and important,) was, in the course of a few years, thrown aside, by many persons, as useless lumber, and neglected by all;—the proprietors of the mines being obliged to sit down, (as it was generally understood) with a heavy loss.

It is impossible to say how much longer this important interest might have slumbered, had not the city of Philadelphia—dormant also, till a very late period, as to the immense and invaluable beds of anthracite, in its own vicinity—at last discovered how to apply it to use; and had not New-York, soon after, learned from Philadelphia the same important lesson.

Still, it is believed that most persons have remained, until recently, *rather sceptical*, with respect to the Rhode-Island coal. As I have myself been, to a certain extent, of this number, and as *I have not, either on my own account, or that of my friends, the slightest interest in any concern of this nature*, I proceed, with the more pleasure, to give my testimony in favour of the anthracite of Rhode-Island—having already expressed fully my high opinion of that from Pennsylvania.

In my account of this anthracite, I mentioned that I could not obtain from that of Rhode-Island, any gas, by igniting it powerfully in a coated iron tube, in a Black's universal furnace. I remarked also, that the specimen was one that had lain several years, in a garret, under which circumstances, it might perhaps have parted with any *imbibed* moisture, although it would hardly have given up any *combined* water. It is obvious, that if water, in either of these forms be present in the anthracites, they ought, when intensely ignited, to afford, by the decomposition of the water, more or less of inflammable gas.

To bring this matter to a decision, I took two ounces of the very same parcel of dry Rhode-Island anthracite, which, in the former trial, had failed to afford any gas, and conducting the experiment, in all respects, as before, except that I poured a small quantity of water into the tube, so as to wet the fragments of dry anthracite, I proceeded to apply an intense heat.

From two ounces of the anthracite, which, when dry, had given not a bubble, *I now obtained six wine pints of inflammable gas.*

A similar trial, upon the same quantity of coal, immediately from the mines, gave also *six wine pints of the same kind of gas.*

A third experiment, upon another similar portion, also just from the mines, *afforded thirteen wine pints of gas.*

The difference between these two latter specimens, seems to have been, that the former was from the layers of the coal that were more dry, and the latter from those that were more thoroughly wet.*

These experiments prove, that the gas obtained from the Rhode-Island anthracite, proceeds, principally, if not entirely, from the decomposition of water, by the action of the ignited carbon. At least, it is demonstrated, that this is the reason why no gas was obtained from the dry R. I. anthracite, in the experiment related in the former memoir. In that communication, I expressed the opinion, that gas would be obtained, from pieces recently from the mines, and this has been fully verified by the result.

The anthracite of Rhode-Island then affords inflammable gas, as well as that of Pennsylvania. Referring to the table given in the former memoir, we find, that the gas from the Pennsylvania anthracites was considerably more abundant, than that *now obtained* from the coal of R. Island.

I am, however, at this time to state, that the inflammable gas procured in these chemical processes appears, as regards the comparison between the anthracites of Pennsylvania and R. Island, not to give an exactly correct criterion of the quantity of flame, which they relatively exhibit, while burning in domestic use. A correspondent, who had acquired considerable experience in the use of the anthracites of Pennsylvania and R. Island, remarks in a letter now before me—"that there are no points of difference between them so remarkable as the *greater quantity of flame, and the less amount of residuum* in the R. Island coal."

I was surprised at this account with respect to the flame, but I can now state, from my own observation, that the combustion of the R. Island anthracite, in the hall or entry stove, (described in the former communication,) gives a flame not inferior in quantity to that afforded by the best anthracites of

* I am not quite certain, that in this latter experiment, the quantity of gas was not somewhat increased, by a small portion of the materials of a former experiment, that might have adhered to the tube which had, however, been carefully cleaned.

Pennsylvania.—Its colour, however, inclines to red, instead of white.

This result is given from the trials made with the coal recently from the mines. I tried also, that which had lain ten years in a dry and warm garret, and a portion of which had failed, in my first experiments, to afford me any gas. This coal, without being moistened, when placed in the furnace upon ignited charcoal, soon became itself intensely ignited, producing a very hot fire, with a moderate flame, but much inferior in amount and in brilliancy to that produced by the wet coal. The stove is at this moment (April 11th, 1826, evening,) burning with much bright flame, and giving a heat in the apartments of 74°, while the thermometer is in the open air 11° below freezing; the ground being covered with snow,* as in mid winter.

The question will immediately occur, why does the Rhode-Island anthracite give less gas in chemical processes, than that of Pennsylvania, and quite as much flame while burning?

The following appears to me to be the reason. The Pennsylvania anthracites are very compact—there is a perfect continuity of parts—no pores or cracks are perceptible, even with a magnifier, and when immersed in water, they do not emit common air, or become heavier by imbibition. Just the opposite of all this, is true of the Rhode-Island anthracite. Although, in the main, compact, it is full of fissures, and few places can be found where they do not occur every half inch or inch. I immersed in water some portions of that which had been kept so long in the dry garret; the air, forced out by the entrance of the water, immediately issued, with a hissing and singing noise, from innumerable cracks and pores, and this process went on for a long time. When other pieces, *recently from the mine*, were immersed, there was no such effect. At least, this was true of the more solid pieces; from these, when immered, scarcely an air bubble escaped. When pieces of a looser texture were treated in the same manner, they emitted a good deal of air, but much less than what was given out by the coal, that had been drying for a series of years. The Lehigh coal, when immersed in

* Yesterday; April 10th, there was a hard snow storm nearly all day; the snow, if none of it had melted, would probably have been 12 inches deep. A cold night succeeded, incrusting the windows of the lodging chambers inside, with frost. To-day, although there has been a bright sun, icicles have remained all day, on shrubs under the southern windows of the house, in the full light of the sun. This was the fact on the next day also.

water, emitted no air at all, as far as could be perceived, only at the end of half an hour, there were innumerable very minute air bubbles adhering to this anthracite, but none of them rose through the water; there was no hissing, and they might perhaps have been evolved from the water itself.

I immersed, for a given time, portions of

1. The dry Rhode-Island anthracite;
*2. Of that which was looser in its texture;
*3. Of that which was firmer;
4. Of the anthracite of Lehigh.

After being immersed about half an hour, the pieces were withdrawn and dried externally, by being pressed repeatedly in a silk handkerchief: they were then weighed;—the result, reduced to the centesimal proportion, (for the pieces were of various size,) was as follows:

R. Isl. anth. very dry,	100 grains gained	64.7	=	164.7
Do. do. looser variety,*	100 gr. -	16.6	=	116.6
Do. do. more compact,*	100 gr. -	00.7	=	100.7
Lehigh anthracite,	100 gr. -	00.0	=	100.

The results fully establish what has been stated respecting the imbibition of water by the Rhode-Island anthracite, and render it probable that no part of the gas from the Lehigh coal is attributable to that cause.

When the pieces of R. Island anthracite, which had imbibed most water, were placed in the stove, upon other portions of the very dry anthracite, which were burning with intense ignition, but without much flame—there was an active decrepitation, occasioned by the sudden production of aqueous vapour, and as soon as the coal was ignited, there was an evident augmentation of the flame, arising, without doubt, from the decomposition of the water. It is obvious, that the gas from the Rhode-Island coal is derived, principally, from the decomposition of *imbibed* water, and that there can be very little *combined water*, or hydrogen, in that anthracite. On the contrary, most of the water, or hydrogen, in the anthracite of Pennsylvania, appears to be combined. Therefore the quantity of inflammable gas, obtained in the chemical processes, agrees with the actual flame while the coal is burning. But in the Rhode-Island coal, the water being chiefly imbibed, mechanically—a portion of it is distilled away, in the chemical processes, before the carbon is suffi-

*Recent specimens, only a few days from the mine.

ciently ignited to decompose the water; while, on the contrary, in *the actual combustion* of this coal, this water is not *distilled away*, in any considerable degree, but is *decomposed*, because the fuel is brought, in the first instance, into contact with other fuel, in a state of intense ignition, for which reason the decomposition of the water and the consequent evolution of hydrogen, commence, from the very first, and the continuance of this decomposition is insured, because the aqueous vapour must pass through successive layers of ignited carbon, with which the furnace is, more or less, filled. Still I am inclined to think, that there is a small portion of *combined* water in the Rhode-Island anthracite, which, although not decomposed by the heat communicated, externally, through an iron tube, by a charcoal fire, *is* decomposed, by the more intense heat which this coal itself, *while burning*, produces.

Whether these reasonings are correct or not, is of no practical importance, as regards the use of the Rhode-Island coal in domestic economy, and in the arts; for, when it has not been previously dried, it burns not only with intense ignition, but with abundant flame.*

To those who are not familiar with chemical facts, it may not be amiss to remark, that much of the flame of most kinds of fuel arises from the combustion of the hydrogen gas, which decomposed water evolves, and that ignited carbon always decomposes this fluid with energy.

Of this fact, many instances might be mentioned. When a fire engine dashes a shower of water, *in moderate quantities*, at a time, upon a building, burning with great fury, the flame, instead of being diminished, is, *for the moment*, increased, sometimes darting up in a vast volume, with the first affusion of the water. The red hot carbon, is here the decomposing agent, attracting to itself the oxygen of the water, and flying away with it, in the form of carbonic acid gas, while the hydrogen is let loose, and taking fire, adds to the volume of flame. If the water be then poured on in torrents, the temperature is lowered, both by contact and by the formation of steam—the carbon ceases to decompose the water as the fire declines.

* The impression, that this fuel burns with little flame, which I mentioned, (Vol. X. p. 337,) was derived, probably, from the combustion of very dry anthracite, *from the upper parts of the mines*, then just opened, and the art of burning this fuel was then very imperfectly understood, and we may therefore presume, that the heat raised in this case, was much less than that which is now obtained even in open grates.

In the same manner, when a little water is thrown into a chemical furnace, burning with great energy,—the hydrogen gas is liberated in such abundance, that the flame not only roars with a loud noise, as it passes with increased violence, and in augmented quantity, up the throat of the chimney, but this vent, being often insufficient to let it all off, as fast as it forms, it darts downward through the grate, and spouts out at the ash pit, forming a jet of fire in the room. This effect was very strikingly exhibited, by the dry Rhode-Island anthracite, which, when powerfully ignited in the furnace, but affording only a moderate flame, threw a very great one into the apartment, when a little water was injected into the fire.

These remarkable effects have been very pleasingly illustrated by Mr. Samuel Morey, in the various papers of his on this subject, printed in preceding volumes of this Journal.

My experience with the Rhode-Island coal has been limited to a short period, but it seems hardly possible, that there should be any mistake on the main points, most interesting in practice.

1. *This anthracite is ignited without difficulty*, by the same arrangement which is usual with the Pennsylvania coal, and it appears to be (to say no more) equally combustible.* I have never attempted to burn it in an open grate, and my impressions are strengthened, that *this is not the best method of burning the anthracites*, although it is understood, that, by good management, they are made to burn in this manner; but many persons become dissatisfied and disuse their grates.

2. *The best method of burning this coal is in the iron furnace, or stove lined with fire bricks.*†

In this manner the fire is entirely at command, and can be made to produce, at pleasure, a mild or an intense heat.

3. *This coal, unless previously dried, burns with an abundant and bright red flame.* This flame begins to appear, almost as soon as the anthracite is thrown upon the ignited charcoal; within 15 or 20 minutes it is very conspicuous, and in double that time it fills the furnace, and continues, although, after a certain time, diminishing, till the coal is almost consumed. In this particular, in which it was formerly considered as deficient, it excels. If the coal has been long out of the mine, and has been kept in a dry situation, it would be well to sprinkle it occasionally with a little water: it should

* April 24. I must now say that it appears to me to be more easily ignited.

† June 7. A cylinder of *cast iron* has been, recently, substituted for a lining.

not, however, be more than the coal can thoroughly absorb and decompose, for any thing beyond this, would be injurious, by diminishing the combustibility of the fuel. I find, however, that after being thoroughly wet with rain, it burns freely.

4. *The heat produced by the Rhode-Island anthracite is intense.* The season being so far advanced, I have not been able to compare it exactly, in this respect, with the Pennsylvania anthracites, and cannot positively say, that it produces as much heat as the purest of those varieties of coal; but when it is burning with great activity, I cannot discover any material difference, as far as the sensible appearances, or the effect on the air of the apartments, would afford a criterion by which to judge. It is certain, that the heat is very great, and I have no doubt that it will be sufficient for every purpose of domestic economy, and of the arts, to which it may be applied.

5. *The gas emitted by the Rhode-Island coal, is light carburetted hydrogen,* mixed, of course, with carbonic acid gas.

I have not observed any odour of sulphur, when the door is opened to throw in more fuel, and even when I injected water upon the highly ignited coal in the furnace, (as already related) although the flame burst forth into the room, and filled it with ashes, there was no smell of sulphur; the odour was simply that of light carburetted hydrogen, and I have constantly observed this to be the fact whenever *any* smell was perceivable.

I cannot say, that none of the varieties of this coal will give a sulphureous smell, but I have never observed it.

It is stated by a correspondent, that having an entry stove, the tube of which, being without a cap and passing out at the window of a third story, was liable to be acted upon by the wind, the current was thus, on a particular occasion, reversed; the flame returned downward, "passing under, through the bars of the grate, and curled up under the bottom of the stove, making a beautiful fringe of fire all around it, which remained for some time: a smell was perceptible, but only slightly disagreeable." A similar occurrence, when the furnace was charged with Lehigh coal, produced so disagreeable a smell, that it became necessary to ventilate the house.

This difference in the smell of the gas from the two kinds of coal, I have observed: where there is a good draft, it is of no practical importance, and where there is an intermitting

one, there will always be more or less of inconvenience, and there may be even danger, as the gases emitted by both descriptions of fuel are deadly.

6. *The Rhode-Island anthracite produces a heat of long continuance.*

Here, again, I must remark, that not having had an opportunity to burn this fuel in the severest weather, I cannot, in this particular, compare it exactly with the Pennsylvania anthracites, but I have perceived no remarkable difference. The furnace being filled at 10 o'clock P. M., burns through the night, maintains the apartments at a comfortable temtemperature,* and contains ignited coals at 6 o'clock in the morning, sufficient to re-establish the fire, without any thing added, except more fragments of the anthracite.

8. *In general, the Rhode-Island anthracite, although dissimilar in appearance, is very similar in its effects, to the anthracites of Pennsylvania;* and the remarks made in the notice in Vol. X. may be considered as substantially applicable to both. I do not mean to interfere with the claims of proprietors, or with the preferences which (unconsciously perhaps) are influenced by local considerations. In a national point of view, all these anthracites are to be regarded as eminently valuable; they are a vast treasure to the community, as well as to the proprietors, especially as most of the beds of bituminous coal are remote from our maritime regions, with which the anthracites of Pennsylvania hold an easy communication, by rivers and canals, and the coal of Rhode-Island is contiguous to the sea, so that being once on ship board, it may easily be conveyed to any place accessible to ships. Our territory is rich in mineral combustibles; the east in anthracite, and the west in innumerable mines of bituminous coal.

Characters of the Anthracite of Rhode-Island.

The Colour is steel gray—greatly resembling that of plumbago, to which substance it often approximates.

Many of its surfaces are covered with a thin film of a substance not to be distinguished from plumbago, as it has the same lustre and softness, and stains the fingers and marks paper in the same manner. A true plumbago is found occa-

* 60 to 65 degrees in the morning, when the thermometer out of doors is 20 degrees.

sionally among the slates which accompany this anthracite.*

Change of colour does not appear to be a common incident of the Rhode-Island coal. Its colour is remarkably permanent. Atmospheric influence, including the various agencies of temperature, electricity, &c. aided by chemical action, often extends many feet and even fathoms into the solid materials of rocks themselves; so this coal is often altered in the same manner, and the seams are then lined with red oxid of iron, giving fresh pieces a mottled appearance. Such masses are, however, always rifty, while those that are solid, are, in a great measure, free from these appearances.

Play of colours is, I believe, never observed upon the Rhode-Island anthracite, at least to any degree that is remarkable. The beautiful hues of the iris, so common in the Pennsylvania anthracites, are in vain sought for in that of Rhode-Island, at least in any specimens that I have seen.

Occasionally there are thin veins of pyrites, which, by their decomposition, produce both change and play of colours in a small degree, and to a moderate extent.

The lustre of this coal is semi-metallic. In fresh and uninjured specimens it is shining, and even sometimes splendent, and in such cases the lustre is composed of the metallic, the vitreous and the resinous, united.

* Professor Vanuxem's analysis of the anthracite of Rhode-Island, and of several varieties of plumbago, (Vol. X. p. 1, 104—5 and 6, of this Journal) evinces that there is no *constitutional* difference between these substances, which contain the same constituent parts, varying only in proportion. Carbon seems to be the only *essential* ingredient; the iron, manganese, silex, alumine, &c. being only *accessory* ingredients. It is possible that iron may be essential, but it is in small and variable quantity, and its variable proportion militates against the idea of its being in true chemical combination, with the carbon. The absence of bitumen from the anthracites is the essential point, in which they differ from the common or bituminous coal. The carbon appears to be in the same condition, substantially, in which it exists in the diamond, and were it freed entirely from foreign substances, and crystalized, it would be diamond.

I am not aware, that plumbago has ever been burned in furnaces, for the purpose of generating heat, for domestic economy, or for the purposes of the arts, but after what we now see done, every day, with anthracite, it is probable that plumbago might, were there any inducement, be consumed in furnaces, burning with intense ignition, like the anthracite. Its combustibility, in chemical experiments, has long been known, and no one now questions the combustibility of the diamond.

Although it is probable that the very dense aggregation of this substance would prevent its burning in furnaces, (were it possible to accumulate a sufficient quantity, and to prevent such small bodies from choking the draft) the whole world now knows, that it burns in the solar focus, and rapidly in the focus of the compound blow-pipe.

Many pieces resemble, very strongly, the compact magnetic iron stone; others in the *kind* of lustre, approximate more to pitch stone and semi opal.

The hardness is moderate: it is scratched by a knife, and the powder is black; by intense ignition, it becomes hard enough to scratch glass.

The mean specific gravity is 1.75, but there is considerable variety in different specimens.

It becomes electric by heat, so as to move a delicate needle, suspended by a thread, but it is not rendered electric by friction.

Its structure is slaty and columnar.

In the direction of the schistose rocks, between which it lies, the structure is slaty, but it is separated in the opposite direction, into innumerable columnar masses, so that a considerable piece has a strong resemblance to a group of basalt or trap rocks, presenting a series of vertical fronts and irregular columns retreating, by escarpements. In consequence of this structure, this coal breaks into cubical fragments and parallelopipeds, and not into wedge-shaped pieces.*

It appears probable that the seams, vertical to the slaty structure of this coal, have been rendered more numerous and more evident, by the injuries which time has effected, upon the upper strata, but it is scarcely credible, that they should have been produced in that way, and they therefore belong, as it would seem, to the original structure of this mineral.

The fracture is compact. In using the word fracture I here refer to the aggregation of the parts, that are interposed between the seams depending on the structure already pointed out. These parts present a multitude of small solids, which have a different structure in opposite directions. Parallel to the slaty structure, the fracture of these little masses is very compact, and slightly granular, like the most compact iron ores; but in the other direction it is smooth, even, almost specular, and not unfrequently inclining to flat con-

* This peculiarity of structure has an important effect on the combustibility of the coal. When it is thrown into the furnace, it is not prone to become choked: the pieces lie so that the air readily finds its way among them, and for this reason, as well as others, this anthracite kindles easily and burns freely, and is less apt to become choked than the Pennsylvania anthracites. The small coal, also, is easily burned. If it be introduced, when the furnace is active, it burns readily, for even the small prismatic fragments lie so loosely, that the current of air passes freely. Very little of this coal is, in the breaking, reduced to powder, and for this reason there is not much loss in using it.

choidal. A similar fracture is sometimes observed running in a diagonal direction through these small solids.

It is not improbable that in exploring for this anthracite, it will be found, that the masses which come from the greatest depth, far removed from the action of meteoric causes, will be found to be more firm and compact than any hitherto discovered.*

Composition. 100 grains contain from 90 to 94 grains of carbon, the rest being iron and earth. (Meade.)

100 grains contain	carbon	90.
	water	4.90
	oxides of iron and manganese	2.50
	loss	43
		100

In another specimen,

100 grains afforded	carbon	77.70
	water	6.70
	silex	8.50
	oxides of iron and manganese	7.10
	alumine, a trace	
		100

(Vanuxem.)

The ashes are not more abundant than in the Pennsylvania anthracites. They are of a reddish brown colour, and are readily taken up by the magnet. A true furnace slag is formed during the combustion, and requires to be removed, as it impedes the draft. This slag is principally of a shining black colour—it is partly compact and partly cavernous, and masses as large as a pea are instantly lifted by the magnet. The powder of the coal before combustion is not magnetic.

* It is very curious, that, notwithstanding the peculiar structure that has been pointed out, the Rhode-Island anthracite is very hard to break, except when the masses are thin. A cubical block, measuring about two feet, each way, resisted the heavy blows from the head of an axe; it was difficult even to sever the pieces, by using the edge of this instrument, and it became necessary to apply stout iron wedges, driven by a beetle. It is difficult also to break the smaller pieces, with the poker, when they are ignited in the furnace.

Chemical Characters. These have been already sufficiently indicated in the preceding remarks. It remains to be observed that this anthracite decrepitates when thrown into an ignited furnace, but not so powerfully as the anthracites of Pennsylvania.

Foreign bodies. I have seen in the Rhode-Island coal, only small portions of pyrites. Between the seams of this coal, there are found thin veins or films of greenish talc, generally not thicker than the blade of a pen-knife;—chlorite and quartz are found in the same situation, and these foreign bodies, in addition to the earths which appear to be combined or mixed in the coal, and to the iron, contribute to form the slag. Asbestos is found in the slaty rocks, accompanying the coal. These slates are not bituminous, but they are often impressed by ferns, (and other plants,) and these copies are in many instances singularly bold and distinct.

Characters of the anthracites of Pennsylvania.

Having, in the last volume of this Journal, written rather fully as to the general characters and economical uses of this coal, it remains to state its characters as a subject of scientific mineralogy. The slight differences in this anthracite, from the various localities, are scarcely appreciable, and in a scientific view appear to be unimportant.

The colour is black, and in this particular, there is very little variety: in some specimens, it perhaps inclines a little towards gray, but the difference is scarcely perceptible.

Change of colour. Like the Rhode-Island coal, it appears liable to very little change of colour, nor do we observe in its seams, any of those marks of iron rust that are so common in the other, and which give to many of the fragments, a coarse and unsightly appearance, far removed from any thing that most persons would suppose to belong to a combustible body.

Play of colours. There is not in this anthracite any thing like the *chatoyement* of Labrador feldspar, adularia, fire or Carinthia marble, &c.—but a splendid iridescence often adorns the surfaces, exposed by fracture, and it appears to have arisen from the infiltration of water, charged with iron, derived probably from the decomposition of pyrites.

Whatever may be the nature or the origin of the colouring matter, few minerals equal the Pennsylvania anthracites, in

the richness and beauty of these adventitious colours. The most brilliant are blue, green, yellow and red, which, being disposed in clouds and bands, upon a ground of brilliant black, form a combination rarely surpassed in beauty.*

The lustre is resplendent and vitreous. There is a very high natural polish, which, united with the black colour, imparts to this substance, singular beauty. Its aspect is very much like that of obsidian, and from its appearance, we should sooner take it for a vitreous than a carbonaceous compound.†

Hardness. This anthracite is impressed by the knife, but it wears files and saws, thus evincing that its integrant particles are hard. The powder is black, and soils the hands like charcoal. When the fragments, such as are used for burning, are freed by washing and wiping, from the fine dust of the coal, which adheres to them, they then cease to soil the fingers, and will not tarnish even white paper, or clean linen, although impressed upon the surface with considerable force.‡ By strong ignition, this anthracite becomes hard enough to scratch glass.

The mean specific gravity is 1.55. The Schuylkill variety appears to be a little less; about 1.52; and it is very possible that an examination of a greater variety of pieces would present also more variety in the results.

The structure is slaty—apparently, in the direction of the strata, (for I have not seen it in place.) In many specimens, this structure is very striking, and in all that I have seen, it is easily traced, sometimes with slight flexions of the layers, but in general they are straight. There are, however, no traces of the columnar structure, in the cross direction; a peculiarity that is so remarkable in the Rhode-Island coal. The slaty structure may probably be regarded as the result of the general geological laws, that influenced the deposition of the coal, considered as a member of the series of rocks, of that peculiar formation.

* I have selected specimen after specimen from the fragments that were about to be thrown into the furnace, until the shelves were incumbered and the least beautiful were at length committed to the fire.

† One is tempted to save from the fire, many specimens, even when not iridescent, until they accumulate to an inconvenient degree. Few of the specimens in cabinets are equally beautiful, and I am not informed of the existence of any anthracite, which admits, in this respect, of comparison with this.

‡ This is true, in a degree, of the Rhode-Island coal, but it is much less remarkable in this particular.

The fracture is a distinct thing. *This is compact*, if the division pass in any other direction than in that of the shistose layers. It is the variety of the compact fracture, which is called conchoidal, and it is remarkably perfect and beautiful, having often the wrinkled appearance of a shell, similar to what we observe in obsidian; the surface is otherwise very smooth.

The form of the fragments is generally wedge-shaped, with sharp edges, and the pieces are very irregular, no two being alike, although they have a general similarity. The fragments are shaped very much like those of gun-flint and obsidian, and they rarely approximate to cubes and prisms.* This coal is very brittle, and breaks in the furnace much more easily than the Rhode-Island coal.

Composition of the Lehigh anthracite.

Carbon	90.1
Water	6.6
Silex	1.2
Alumine	1.1
Oxides of iron and manganese	0.2
Loss	8
	100

(Vanuxem.)

Chemical characters.

The account of these properties was anticipated in the former paper, and in my experiments, published in this Journal in 1823. It may be remembered, that I found the anthracite of Pennsylvania a very poor conductor of galvanism, while that of Rhode-Island was a good one.

The difference arises, apparently, from the smaller quantity of metal contained in the former. This is apparent, also, in the light gray colour of the ashes of the Lehigh coal. These ashes are only slightly magnetic; those of the Schuyl-

* In this respect, the Pennsylvania anthracite differs from that of Rhode-Island. There is, for this reason, a greater tendency in the Pennsylvania coal, to become choked in the furnace; it requires more care in putting it in, and the small coal is more difficult to burn. I have mentioned, in a preceding note, that the small coal of the Rhode-Island anthracite burns with ease, and rarely impedes the draft, if introduced when the fire is active.

kill coal are however much more magnetic, and the slags which form in the furnace, are respectively much more magnetic than the ashes. The ashes of the Schuylkill coal are of a reddish colour, not unlike those obtained from the Rhode-Island coal, and it is not improbable that the colour is owing to the same cause;—although I am not aware that any analysis of this coal has been executed.

Foreign Bodies. The structure of this coal is so close that there is not room for any foreign body to be interposed in seams, which in fact do not exist, except between the great masses of coal and the contiguous layers of strata. There is rarely on these surfaces a plumbaginous aspect, and when it exists, it is less remarkable than in the Rhode-Island coal. The only foreign bodies that I have observed in this anthracite, are some portions of pyrites, generally small—some of them cupreous—more frequently distinct spots and layers of carbon, exhibiting the precise appearance of vegetable charcoal. Its structure is, generally, in fine fibres; it is nearly without lustre, and presents a striking contrast to the brilliancy of the surrounding anthracite.

The slates, which are contiguous to this coal, abound with distinct and beautiful vegetable impressions, as described by Mr. Cist, in his memoir, in Vol. IV. of this Journal, to which I refer for the geological relations of this coal.

Miscellaneous Remarks.

Where the conducting tube, that connects the furnace with the chimney, is vertical, it appears to be strictly true, as stated in the former memoir, that it needs little or no cleaning. But I find that where there is a considerable length of horizontal tube, the ashes, transported by the strong current, accumulate in considerable quantity, and although they are entirely incombustible, and therefore completely different from the soot of a common chimney, it is requisite to remove them occasionally. Once, or at most, twice, in the course of the season, will be sufficient. The tube must be taken down, carried out of doors, and the ashes poured or jarred out, simply by raising the tube on end. As they are entirely dry, they run out as sand would do. Their colour, modified by the black dust of the coal, is darker than that of the ashes, which fall through the grate.

The ashes of the anthracites are recommended in Say's Entomology, as being useful in destroying the worm that infests the roots of the peach tree.*

Some persons suppose, that fire, maintained by the anthracites, must, on account of the intense heat which the combustion of this fuel produces, be necessarily oppressive. It is true, that a degree of heat may easily be generated, in this manner, that is greater than is agreeable or useful. But an energetic agent should not be rejected for the very quality which, when properly regulated, constitutes its peculiar excellence. It is hard to push on the sluggish, spiritless horse, but the generous courser is easily regulated by bit and bridle, and, although capable of rapid speed, readily submits to a moderated movement.

All that is necessary, to avoid the inconvenience alluded to, is to place the stove in the proper situation—to regulate the supply of fuel and the draft of air, according to the weather, and to open and shut the doors of the rooms, as may be necessary. In the severest weather, it may sometimes be necessary to close the communication with every room, except one, until that room is brought to the desired temperature, when another door may be opened, and a second room warmed, and so on, until we reach the limit of energy belonging to the means in hand; for, even the anthracites are not omnipotent in subduing cold, and those persons will be disappointed who expect every apartment of a great house to be heated, like a sitting parlour, by one fire, perhaps fifty feet from some of the rooms. The air of a considerable number of rooms may, however, be agreeably tempered, and two or three that are immediately contiguous to the furnace below, and as many more at the head of a stair case, at whose foot the furnace stands, may, (unless when the weather is severe,) be effectually warmed.

It is supposed by some persons, that the anthracites must, of course, be out of the question, in the mild weather of spring and autumn. On the contrary, the anthracite fire, (I speak of it as sustained in the lined furnace) is particularly

* "Mr. J. Gilliams has certainly derived great advantage from the use of the cinders of the common anthracite, which is now so generally introduced as a fuel; he opens a small basin around the trunk of the tree, and fills it with the cinders; he informs me that the trees thus treated, have assumed a more healthy appearance than others, and they are not at all infested by this destructive insect." (Say's Entomology Art. Egeria Exitiosa.)

agreeable in such weather. This day, (April 16, 1826,) has been one of that description; the thermometer, out of doors, being over 50° of Fahr. A small fire of the Rhode-Island anthracite, from four to six inches in depth, and sometimes burning freely when there were not more than two inches of coal, the inner doors being open, has diffused a mild and agreeable warmth through nearly the whole house, pervading a space of more than eighty feet in length, thirty in breadth, and twenty in height.

In this manner, the family are enabled to occupy apartments, where they could not otherwise remain, without separate fires, and they pursue their various avocations dispersed freely, as in summer. To produce this desirable result, all that is necessary, is to regulate the fire with a little more care, much less, however, than is necessary under similar circumstances, with open fires. The fuel must be supplied rather more frequently than in winter, and in smaller quantities, perhaps once in two hours, and the register drawer must be kept most of the time shut. It is a mistake to suppose, that the anthracite fire will go out, unless there is a great mass of fuel. Whatever may be true of the open grate, this is not the fact in the close stove; and if, at any time, the fire has been suffered to decline, to that degree (as it sometimes happens) that the adding of more anthracite would extinguish instead of reviving it, then it is necessary to introduce a little charcoal, and in a few minutes, it will be in a condition to receive the anthracite and to kindle it anew. It rarely happens, however, that it is requisite to use charcoal, except once in the day, that is, on kindling the fire in the morning, nor is it necessary even then, provided the fire has been suffered to burn through the previous night. For the warming of large establishments, hospitals, asylums for the insane, churches, colleges, hotels, &c. and where it is important for the preservation or recovery of health, to have a uniform temperature, regulated even by the thermometer, the anthracite must be an admirable fuel. With this aid, it would be very possible to establish in New-England, or in Canada, the climate of the Azores, of Madeira, or of the West-Indies. Even in countries where very active fires are not necessary, but where the climate is, for several months, too cold to admit of doing without them, as in the middle and even in the southern states of this country, the anthracite, especially if burned in a fire-room above, or in the cellar, (a space being appropriated

to this object,) would afford and diffuse through a large establishment, that mild temperature, which is so favourable, both to health and comfort. In regard to the pleasantness and utility of this fuel, as it may serve to answer the enquiries of other families, I take the liberty to mention the experience of my own, during the last six months; in which, (except for cooking,) we have scarcely used any other fuel. At the same price, the family would now greatly prefer the anthracite, to the best wood. The uniform and permanent heat, its diffusion through several apartments, and the connecting halls and passages, thus giving in winter, the freedom and space of summer, the diminished liability to catch cold, because we have not to encounter currents of cold air in the sitting rooms, and to be immersed in a freezing climate, in the halls; the freedom from smoke, and, in a great measure, from ashes and effluvia, the perfect security from fire, the greatly diminished trouble, hardly any attention being required from the females of the house, the economy of carpets, especially around the fire place, and the economy of money, since this fuel affords a given amount of heat at a lower expense than any other: all these advantages conspire to recommend the anthracite fuel to general use, in all parts of our country accessible by water. I have a high opinion of the value of the bituminous coal, and it would be very desirable that more mines of this fuel should be discovered, east of the Alleghany mountains; but if the election between the two were left to us, we should not hesitate to prefer the anthracite.* It is very happy that, while central Pennsylvania is so richly stored with this combustible, New-England has also an abundant local resource in the mines of Rhode-Island. The anthracite is found also at Worcester, which it is expected will, ere long, be connected by a canal, with Providence, at the head of Narraganset Bay. The same geological formation in which the Rhode-Island mines are found, extends to Boston and elsewhere, and very possibly, the anthracite may be found in other places in this region.

The great valley of the Connecticut, also, admits (at least in part,) of the existence of the anthracite, as well of bituminous coal, and many traces of coal of various qualities—generally, however, of the bituminous kind—have been found in widely dispersed parts of this district.

* My own impressions were, at first, very different, until observation and experience convinced me, that my earlier views were erroneous.

The anthracite furnaces are liable to an inconvenience, which is easily prevented, if attended to in season. The semi-vitrified matter, composed of the impurities of the coal, and which forms the slag, accumulates by adhering to the fire-bricks, with which, by partial fusion, it forms a firm union. It should be removed by the poker every morning, when the furnace is cleaned: it is easily done from day to day; but if neglected, it increases to an inconvenient degree—thickens the lining all around—narrows the place for fuel and draft, and much diminishes the power of the furnace.

Even when thus accumulated, it can be removed by taking off the top of the furnace, and placing the straight poker with its point upon the excrescence, when it is made to break off by the blows of a hammer, taking, however, a thin film of the fire-bricks with it, but not injuring them materially.

Appendix, May 11, 1826.

I have been just favoured with a copy of a memoir, by Mr. Marcus Bull, read before the American Philosophical Society of Philadelphia, April 7, 1826—entitled:

"*Experiments to determine the comparative quantities of Heat, evolved in the combustion of the principal varieties of wood and coal, used in the United States, for Fuel; and also to determine the comparative quantities of Heat lost by the ordinary apparatus made use of for their combustion.*"

This memoir is the result of a long course of experiments, evidently conducted with great care and skill. It is replete with interesting information, and is to be regarded as one of the most important contributions of science to the arts and to domestic economy, which has been made for a long time in this country. It is worthy of being carefully studied, both by scientific and practical men, and for the sake of the latter class, it might be well if any analysis of this elaborate and detailed paper, presenting, in a lucid and concise form, the practical important results which have been obtained by Mr. Bull—were prepared for extensive circulation.

I cannot discover in the memoir of Mr. Bull any important variations from the results which I have presented.

Mr. Bull finds the specific gravity of the anthracites considerably less than they were found by me, and less than they are stated to be by systematic writers. Whether this is imputable to variety in the weight of different specimens from the same mine, or to inaccuracies in my experiments, I can-

not at present decide.* Neither is it in my power to say whether the Rhode-Island coal is *generally* inferior to the Pennsylvania anthracites, *in its power of imparting heat*, or whether the deficiency found by Mr. Bull, of 28 parts in 99, was imputable in whole or in part, to accident in the selection of the specimens. It is stated by those conversant with the mines, that there is in this respect, much variety in the coal of Rhode-Island. Should it prove on farther trial, that the Rhode-Island coal contains less combustible matter, *under the same weight*, the price in the market will of course be regulated accordingly. A difference it is very possible there may be on this point, in favour of the Pennsylvania coal, but I should not think, from any thing that I have myself observed, that *the average difference in the large way*, would prove as great as the experiments of Mr. Bull would indicate, although I have entire confidence in the accuracy of those experiments in the given case.

P. S. *May* 17, 1826.

It is proper to state, that on taking down the tube connecting the anthracite furnace with the chimney, after burning the Rhode-Island coal, nearly three weeks, the accumulation of ashes was found to be seriously greater than when the Pennsylvania coal was used. The colour of the ashes was dark gray, almost black. It was partially magnetic, sufficiently so to form a festoon between the poles of a horse shoe magnet, but the ashes were perfectly dry, like sand, and adhered only very slightly to the tube. Should it prove to be the fact, that more ashes, arising from impurities, or from unconsumed coal, are deposited in the tube, when the Rhode-Island coal is used, than when that of Pennsylvania is employed, it may be proper to enlarge the diameter of the tube. It is probable, that in a vertical tube, very little ashes will be

* June 8, 1826. My friend, Prof. Olmsted, has, at my request, repeated, with a very accurate apparatus, the experiments on the specific gravity of the R. I. and Lehigh coal;—the former he makes 1.77, the latter 1.55—corresponding, in the one case, *exactly*, and in the other, *nearly*, with my results. Mr. Bull gives, for the Rhode-Island coal, 1.438, and for the Lehigh, 1.494. We must impute these differences, to variety in specimens.

June 9. A letter from Mr. Bull, this moment received, in answer to one from myself, contains the following passage:—"In regard to the variations, in our results, as to the sp. gr. of the coals, it is very probable, as you suggest, that it may have arisen, in part, from the difference in the specimens made use of; but as mine were made *positively dry*, and covered with a compound impervious to water, my results should be less than those which would be obtained without these precautions, as these coals, I believe, present fissures, more or less, in almost all instances, and particularly the R. Island, in which the largest variation exists.

found, except at the elbow joint, whatever fuel is employed, but I am persuaded that a larger conducting tube than that which has been introduced in Philadelphia, would be advantageous, especially where there is any considerable extent of horizontal communication.

I ought perhaps to add, that, at the close of the season, after the experience of more than six months, I find the collection of light ashes upon the sides and ceiling of the apartments, somewhat greater than I had supposed when the former essay was written, but there is no serious inconvenience, as it is easily dusted away, and leaves very little permanent effect.

Art. VII. *Proofs that general and powerful currents have swept and worn the surface of the earth.*

TO PROFESSOR SILLIMAN.

Sir,

There is one circumstance connected with the earth's surface, which has not, that I am aware of, been noticed by any writer on Geology. The surface of every portion of the mass of rock, composing the nucleus of the earth, and which has not been exposed to the action of the atmosphere, is found worn quite smooth, and this equally, whether the covering of earth be shallow, or deep, of whatever species of rock the mass may consist, or however unequal and irregular, may be the form which it has assumed. The common appearance of the surface is highly artificial, as if worn down by some powerful but not very delicate agent. The harder parts have in some instances, especially when forming veins in a softer stratum, the *feeling* of being polished, but the general character of the surfaces, although smooth to the eye, is somewhat rough to the touch, with slight grooves or channels, running in a uniform direction, very nearly north and south, but from a little west of north to a little east of south.

This fact has appeared to me a very striking and important one, and it is a singular circumstance that it should not have been noticed by the numerous writers, who have carefully investigated so many circumstances connected with the changes which the earth has undergone. These changes have al-

ways been considered a subject of deep interest, and have given rise to different theories, none of which are satisfactory, and however we may be inclined at times, in despair, to abandon as hopeless, the inquiry in what manner they have been brought about, it will occasionally force itself upon us. When we meet an immense mass of rounded pebbles, at a great distance from the bed of any river, nay almost on the tops of mountains, we cannot but speculate on the question how they came there.

It has appeared to me that the most simple mode of accounting for some, if not all of these appearances, is the supposition that a change has at some period taken place in the velocity of the earth's motion on her axis.

The surface of the earth on the equator revolves at the rate of more than 1000 miles per hour, or nearly 1500 feet per second, a rapidity of motion, of which it is not easy to form a very precise idea, without comparing it with other velocities, which are familiar to us. Thus it is greater than that of sound, which is estimated at 1100 feet per second, and the *greatest* speed of a ball, impelled by gunpowder, being about 1700 feet per second, we may safely assume the velocity of the rotary motion of the earth at the equator, as equal to the velocity of a cannon ball.

We have no idea of circular motion bearing any proportion to it. The surface of a spindle of three inches diameter, revolving 4000 times a minute, passes through only 50 feet of space per second—and a wheel of wrought iron, of three feet diameter, will, it is said, fly in pieces before it reaches a velocity of 400 feet per second.

It is true this effect would be produced on the wheel by the centrifugal force, which acts with small comparative power on the earth, on account of its vastly greater diameter. But with respect to the water, floating on the earth's surface, and held so nicely balanced by the power of gravitation, it evidently must possess this same impetuous motion with the solid parts of the globe, and should the rotary motion of the earth suddenly cease, from any cause not acting equally upon every particle of this fluid, the whole mass of water not acted upon, would continue to rush forward with this inconceivable velocity, until overcome by opposing obstacles, or exhausted by continual friction, and the counteracting power of gravitation. Without pretending to calculate the extent of a power so tremendous, it must be evident that it would be more than

sufficient for any conceivable purpose. Supposing the solid earth suddenly stayed, or even slightly checked in her diurnal motion, the Pacific Ocean would, as it were in a moment, rush over the Andes and Alleganies into the Atlantic, which in the mean time would be sweeping over Europe, Asia, and Africa. A few hours would cover the entire surface of the earth, except perhaps the vicinity of the poles, with one rushing torrent, in which the fragments of disintegrated rock, earth, and sand, would be carried along with the wreck of animal and vegetable life, in one, all but liquid mass. The same sweeping flood which might be thus suddenly produced, by a cessation of, or change in the rotary motion of the earth, might have been produced, equally, by the original communication of this motion, and the suddenness or slowness with which this motion should be communicated, would determine the violence of the flood.

The appearances presented on the surface of the earth are precisely such as we should expect after such a catastrophe; —the outer more friable strata of rock, torn out from the solid mass, rounded into boulders and pebbles of every size, or crushed into atoms, according to their exposure and power of resistance; the surface of the harder strata, not forced out of place, as well as of those less exposed by their original position beneath other strata, ground, pounded, worn, in the manner herein described. The disposition of the disintegrated portions of rock and sand, is conformable to this hypothesis, and reconcilable with no other with which I am acquainted; —as the cement should by degrees lose its violence, the more elevated ridges, presenting the most powerful obstacles to the course of the water, would first show themselves above its surface, arresting at the same time, the more ponderous detached rocks, together with the confused mass of pebbles and sand accompanying them; the lighter portions of the latter would be carried off to a lower level, by the farther subsidence of the waters. Thus we find the largest boulders, with immense hills of coarse gravel, piled up in mountainous districts of country, frequently nearly equal in height to the ridges of rock about them, except where the latter shoot up into sharp peaks.

The appearance of the surface of rocks, in place, to which I have alluded, appears to me, however, to be the most striking circumstance in support of this theory. I have noticed this in every part of New-England, and of so marked and di-

vided a character, as to leave no doubt in my own mind of its universality, but it may not be every where so obvious. Our hills show their hard primitive faces wherever a new turnpike requires the removal of the natural soil to any extent, and this hardness of surface withstands for a long time the action of the atmosphere,—while the softer rocks, which show themselves most frequently in alluvial districts, by a short exposure, lose every trace of the original character of their surfaces.*

The long cultivation of the populous parts of Europe, may have tended to change or conceal the character of the surfaces of those rocks which are most accessible. It may also be observed that the direction of the marks caused by this violent friction, indicates a subsequent change in the axis of the earth. Now the parts which were near the poles at the time of this revolution, would be little acted on by it, and would probably shew few if any of the striking marks of friction. A thorough examination of the surface of rocks in the different parts of the globe, may enable us to decide what parts must have constituted the poles at this period. Suppose the equator to have passed over the United States, and the revolution to have been towards the present north pole, according to the indications I have noticed, one pole would have been near the western coast of Africa, the other in the Pacific ocean.

The indications of a flood having passed over the continent of America, from north to south, have been noticed by different writers, whilst like indications in Asia are said to point out its course there to have been from south to north. It will be perceived that a revolution on the axis above assumed, would produce that effect. A current passing round the globe, would of course flow in opposite directions, as regards the points of compass on its opposite sides. It is perhaps idle to speculate on the causes which might have produced such an event, as a change in the axis of the earth, or in the velocity of her diurnal motion—it is sufficient to say, it were as easy to the Almighty power which gave motion to the planets, as their original movement. It is obvious, how-

* It is not however to be inferred that these indications are confined to primitive rocks ; they are no where more striking or more beautiful, than on the pudding stones in this vicinity, the imbedded pebbles being worn down and polished as in the columns of the Halls of Congress in the Capitol. To account for this class of rocks, we must suppose this species of flood to have occurred more than once.

ever, that it is precisely the effect to be expected, should the earth come in contact with a comet, although ever so slightly. Dr. Halley, in an essay on the causes of the flood, written in 1694, suggests that a change has been effected in the axis of the earth, by the shock of a comet, but he evidently mistakes the effect to be produced by such an event. He thinks it would have produced such a commotion in the waters as would have caused them to overflow the highest land, in consequence of their tendency to rush from all parts of the globe towards the spot which received the shock. He probably calculated that this would result from the attractive power of the comet, but this power being so exceedingly small, compared to the rotary impulse possessed by the waters, it is obvious that the effect I have described must be the result of such an occurrence.

At any rate, the indications I have pointed out, appear to me deserving of particular notice, and my object will be answered, should this article attract to them the attention of geologists. A.

Boston, April, 1826.

ART. VIII.—*An account of a new explosive engine, generating a power that may be substituted for that of the steam engine.* By SAMUEL MOREY, of Oxford, New-Hampshire.

TO PROFESSOR SILLIMAN.

DEAR SIR,

HAVING accidentally discovered that the vapour of water and that of spirit of turpentine, when mixed with a very great proportion of atmospheric air, were highly explosive—I have been endeavouring to produce therefrom, a useful mechanical power, and embrace the earliest convenient opportunity to send you an account, and the result of some experiments. I should hope they may, at least in part, find a place in your Journal.

Alcohol may be substituted for water, or added to it in any proportion. The vapour, and atmospheric air, if placed in contact, will in time unite, as Hydrogen gas and

common air do, and become apparently as highly explosive. But the process by natural evaporation, would be too slow, when the use or demand was very considerable, unless the reservoir was very large, when it would then be inconvenient, expensive and unsafe. It was desirable to prepare or manufacture the article as wanted. In time it was effected. It was also very desirable, (and there was not, to me, any apparent reason why it might not be effected,) to command or control the explosions, as we do those of gunpowder, although they are much more violent. Another most desirable object, was, to unite in the same engine, if it possibly could be done, the effect or force of the explosion, with that of the vacuum, which always accompanies it, and that, without rendering it too complicated, expensive, and unsafe. By pursuing a course very analagous to that adopted for the use of gunpowder, it was in a measure, or entirely, effected.

The preparing part of the machine consists of a metallic vessel, or tube, so constructed, that a stream or current of atmospheric air, may pass freely through it, together with the vapour or gas to be made use of, both being impelled through a space interrupted by short turns, or other impediments, the object of which is, to blend, mix, or unite them intimately with each other, by which process they are rendered highly explosive. This apparatus admits of an endless variety of forms. A description of one follows, which is found to be perfectly safe, and probably as convenient as any. Make a box of tin plates, four or five inches wide, and about fourteen long, and seven deep. Divide it horizontally, into four or five compartments, by partitions, which extend from one end of the box to within a short distance of the other end, so that the air, entering the lower part, will be compelled, by the partitions, to travel the whole length of the box, through each compartment, in its ascent to the top;—divide these compartments, by vertical partitions, running the whole length of the box, except at the beginning, or where the air enters and passes out, into spaces, about half an inch apart, which have the double advantage, of effecting by their friction, a rapid mixture of the air and vapour with each other, and also of preventing violence in the explosion, in the box, should one take place. A short tube for the admission of air and other materials into the lower apartment, and another for letting out the explosive or prepared air from the upper one, each covered with fine wire gauze to prevent explosion, will

complete the preparing vessel. The opening to this box should be about two inches in diameter.

The exploding part of the machine, also admits of a great variety of construction. The following may serve as a convenient one. Have a cylinder fitted with a piston or plunger, and connected with a crank shaft, as in the steam engine, let the lower end of the cylinder have a valve of at least half its diameter, opening outwards. This valve may be made of thin soft leather, of the same diameter of the cylinder. This leather is to be tied or fastened to the lower end of the working cylinder, so as to form a continuation of the same. The lower end of the leather cylinder or valve, is to be flattened, so as to bring its inner sides together, for about four or five inches of its length, and kept in that position, by light springs attached to the two edges of the flat part, placing it in a position much like that of a bow and bow-string. This valve is supported, or prevented from being driven into the cylinder, by a plate of metal, of sufficient thickness to bear the pressure of the atmosphere, arched or raised outwards, and perforated with as many holes as can be well made in it; the holes should be from about $\frac{1}{8}$ to $\frac{1}{4}$ an inch in diameter. The end of the cylinder forms the abutment to this arched plate. An air valve, also opening outward, is fixed in the side of the cylinder, just below the piston when down. A pipe from the preparing vessel, is inserted or attached to the side of the cylinder, at from $\frac{1}{5}$ to $\frac{1}{4}$ of the length of the stroke from the top. This pipe should be as short as it can conveniently be, and it should be furnished with a valve next the preparing box, to cut off the communication with it, and a small valve about half an inch in diameter, next the cylinder, to let the inflammable air communicate with the flame of a lamp, so as to take fire, and communicate by the trail to the charge in the cylinder. These valves also open upwards, but as the explosion meets with so little resistance below, they are never thrown upwards. They are worked by beams on the crank shaft, as is also the air valve, or by any other convenient mode. To give a double stroke, it will require two cylinders fitted up in this way, communicating with the same preparing vessel and crank shaft. When vapour is intended to be used, put a little alcohol, or high proof spirit, either alone, or with the addition of a small portion of spirit of turpentine, or put in spirit of turpentine and water, or other materials conveniently capable of evaporation, and the vapour of which is inflammable,

when mixed with atmospheric air, into the lower apartment of the preparing vessel; the proportion of each is not very material. Apply a small lamp, or other heating substance, to raise the temperature to about blood heat, and place the flame of a lamp at the inflaming valve. The piston being down, in its ascent would form a vacuum under it; this is prevented by opening the air valve which supplies the cylinder with common air, until the piston reaches the pipe from the preparing vessel. It then closes, and the vapour valve supplies the remainder of the cylinder, through the preparing vessel, with explosive air, and just before the piston is up, say about ⅛ of an inch, the vapour valve closes at the same time that the inflaming valve opens and shuts, the piston being then still rising, draws or turns the flame of the lamp at the firing valve, though the opening into the pipe, inflames the trail, and it is instantly communicated to the charge in the cylinder; the explosion that ensues, drives out the air from within the cylinder, through the perforated arched plate and leather valve at bottom, which valve instantly collapses and prevents the return of the air. The steam, formed by the explosion and formation of the vacuum, is condensed, by keeping the lower part of the cylinder cool, by surrounding it with water, and suffering the vacuum to inject a small stream of cold water near the bottom—which also keeps the arched plate and leather valve cool. A vacuum under the piston, instantly follows the explosion, which descends by the pressure of the atmosphere, and carries the crank with it, while the same process is repeated in the second cylinder, and the power is taken from the crank-shaft, or piston-rod, as in the steam-engine. When the temperature is low, smaller charges will produce the same effect, if a thin metallic plate of the same diameter of the piston, be introduced into the cylinder, called the charging piston. It is fitted with a small rod, which moves through a stuffing-box in the main piston, so tight that the friction will support its weight. This charging-piston is prevented from rising higher than the vapour-pipe, by its end striking against a stationary point, in its ascent, and forming a partition between the compound air in the cylinder, and the common atmospheric air, thereby preventing so great a mixture of atmospheric air in the cylinder, as to lessen the effect of the explosion.

When the temperature of the box is so high as to give off too great a proportion of vapour, the engine works better by

stopping entirely the working of the charging piston, but not with so good economy. This charging piston should be fully perforated with small holes, lest by accident it should not rise with the working piston, as well as to let the explosion pass freely through it, to clear the cylinder. Wire gauze should also be placed between the vapour and inflaming valve, to prevent explosion in the box, should the vapour valve not close in time. When hydrogen gas is intended to be used, an apparatus similar to Professor Hare's compound blow-pipe, may be attached to the engine, to throw the air and gas, into the preparing box.

A box of the form and size before mentioned, appears to be sufficient to prepare air fast enough, with a small lamp, to furnish from fifty to one hundred charges per minute, for a cylinder of seven or eight inches in diameter, having a two foot stroke, the box being in use only one quarter part of the time; it of course, would supply four such cylinders if the air was constantly blown or drawn through it. To keep up the temperature of the box, would, in that case, probably require more heat, but it does appear, that the more rapidly the air is made to pass over the liquors, the more rapidly it takes up vapour at the same temperature.

The following, are some of the methods, I have successfully adopted, in producing a power from this same source.

I have caused the air, by the effect of the explosion, to be compressed over a column of water to such a degree as to throw it to a great heighth and distance.

I have, in a measure, reversed it, and by forming a vacuum in a vessel above, the water would be driven up, by the pressure of the atmosphere.

I have caused the explosion to compress, in a reservoir, a quantity of atmospheric air, and make use of that compressed air, for working an engine, similar to a double stroke high pressure steam engine.

This mode will make it perfectly safe on account of fire, as the compressed air may be led, in tubes, any distance, before it works the engine.

Sometimes I have made a valve in the piston to open upwards, and fill the cylinder below the piston with the prepared air, and when the piston is about half way up the cylinder, it is at the height of its working stroke; the explosion then takes place. The effect is, that the quantity of air above the piston is nearly doubled; its elasticity or force is also

greatly increased, by a great increase of its temperature, it now reacts on the piston, while a vacuum below, adds greatly to the effect. This mode acts with great energy in a small space.

I have attached to the working piston, thin tubes, about $\frac{5}{8}$ of an inch in diameter, open at top, each one of which is directly over and enters one of the tubes of a condenser, attached to the bottom of the cylinder, which tubes are $\frac{3}{4}$ of an inch in diameter. The prepared air, as usual, is let into the cylinder near the upper end; as the piston rises, it fills with the prepared air, the upper part of the tubes, and the spaces around them, and when the piston is nearly up, the explosion takes effect, but the tubes prevent all violence.

At, or near all of those springs, which are constantly giving off hydrogen gas, engines may be erected (substituting the gas for that of the vapour of the liquors) to work constantly, for every desired mechanical purpose. The engines can be placed in any chosen situation, by only conducting the gas through tubes, and if desired, the air and gas may pass in due proportion through the tubes together, which, with a few short turns, will insure its suitable preparation, although the distance should be short.

The explosive vapour engines will work without any fire, when the temperature of the weather, in the sun or in the shade, is about 80 or 90°, provided the charge be inflamed by the electric spark. With a due proportion of ether, according to the temperature of the weather, it is probable that the engine will work at any time, with only a lamp to inflame the charge.

The less is the proportion of alcohol the higher temperature will be required. So again, the more turns, back and forth, the air makes in contact with the liquor, in the box, the lower temperature will be required to prepare it. If the temperature of the box gets down to about 70°, the spirit of turpentine refuses to come over at all, or at least, in sufficient quantity to give energy to the explosion. I have lately substituted a plunger, in lieu of the piston, and attach the stuffing to the top of the cylinder; it works well and is more convenient. A small bellows is convenient in putting the engine in motion, or the explosive air may be blown into the cylinder, and inflamed, to warm it, and commence the operation.

A very easy mode, to try an experiment, for the purpose of preparing this explosive air mechanically, is to have made a few feet of inch tubes, of common tin plate. These tubes should be turned, once in about a foot, at right angles, and the long part should be filled with small tubes, about ¼ of an inch in diameter. If air is made to pass through this crooked tube, while it contains a single spoonful of high proof whisky and spirit of turpentine, with a proper temperature, it comes out highly explosive, if the current is forced through by a hand bellows, with ever so much velocity. As we now construct the engine and preparing vessel, it is impossible that an explosion can take place, that will injure any one. A few drops of these liquors, on a board in the sun, with a tumbler inverted over them, will explode in a short time, if a flame is applied.

It will not, I trust, appear surprising, that these improvements are patented.

I am, dear sir, yours, most respectfully,

Samuel Morey.

P. S. I am sensible, that a drawing ought to accompany this paper, but at present, it is out of my power to furnish one.

Art. IX.—*Memorial on the upward forces of Fluids, and their applicability to several arts and sciences, and public improvements; for which a patent has been granted by the government of the United States to the author, Edmund Charles Genet, a citizen of the United States, member of the Institute of France, of the Royal Antiquarian Society of London, of the Philosophical Society of New-York, &c. &c.* Analysis by Felix Pascalis, M. D. President of the American Branch of the Linnæan Society of Paris, &c. &c.

Half an age has elapsed since the discovery of aerostation, by Montgolfier, and since a great number of experimenters began to engage in aerial excursions, some for the sake of remuneration, others for scientific purposes and public utility. How many ascensions have been made, in all possible modes, and with different gaseous fluids, could hardly be

described! It is, however, ascertained, that human beings can transport themselves into high regions, and through immense space, with the rapidity of tempestuous wind.* Others have been raised to the height of 3670 toises, equal to that of Mont Blanc, and experienced the same effects as are observed on ascending that mountain. The light of heaven, and the splendor of the sun, were darkening before them; blood was oozing out of their pores, and their thoughts and feelings were evanescent. Had it not been long before ascertained that life could not be sustained at such a distance from the earth, the discovery must have been traced to ærostation. But how many lives of adventurers have been lost in the various efforts to attain the elevation mentioned above, it is useless now to recapitulate, because the perils attending aerial navigation, could not be a rule by which to judge of its advantages, any more than those that are inseparable from common navigation, should form a criterion for that art. Yet the science of ærostatics has been judged to be of little or of no import to the benefit of mankind, in spite of the great labours bestowed upon it, and the improvements added to it, by Degen of Vienna, by Pauli of Geneva, and by Robertson of France. The first, connected the balloon with a parachute, in the form of two wings, which he could really agitate, and was truly a second Icarus, and more fortunate than the first. Pauli figured his balloon like a fish of 90 feet long, with fins of 30 feet, and a tail, or rudder of 15 feet; but it could not be adopted, owing to the enormous expense, (about 60,000 dollars.) Mr. Robertson has performed fifty-five aerial voyages, and has invented a double parachute. He has also instructed his son Eugene, who is now in New-York, and their united labours have produced the design called the Minerva, a vessel of 70 tons, carrying sixty men, which, after striking the shortest line to the ocean, can be safely committed to the waves! Proposals on this subject have been addressed to all the academies of the world, in the expectation that an encouraging subscription might be opened for the ultimate execution of the plan; but we have not heard that any farther progress has been made.

These experiments, and others of inferior magnitude, have, as far as we know, added no new means of safety to ærostation, nor the least power to regulate and direct the march of an etherial expedition to favour either science or human indus-

* Sixty miles an hour, according to Hutton.

try; and the public opinion seems to be fixed in its estimate of the value of a discovery which is nevertheless an irresistible proof of human ingenuity, having thus far availed itself of a portion of the laws of nature, in relation to what Mr. Genet calls the upward forces of fluids.

His Memorial, now before us, commands a new degree of attention, not precisely in relation to those improvements, which seem to have frustrated the expectations of former experimenters, but in regard to others far more important to the arts of industry—experiments which had not been before thought of, and which promise far more successful operations. Indeed, Mr. Genet has rationally inferred from the laws of ærostatics, that a series of phenomena dependent on the laws of hydrostatics could be depended on; and that acting either separately or combined, even with animal and mechanical power, they must increase and multiply our resources in some of our most important public works and industrious arts.

This author, a cotemporary of Montgolfier, but much younger, was present at the first balonic ascension which he performed before the King of France, and soon after, viz. in the year 1783, he read a memoir to the Royal Academy, of which he was a member, on the means of applying the steam power for the propulsion of balloons, inflated with air rarified by fire, and he obtained the applause of that learned and celebrated body.

We might relate other opportunities which he had of deeply propounding ærostatic questions with Bolton, and the celebrated Watt of England, and it matters not that he should not have pursued his original project, however practicable it might be, if he has turned his attention to purposes still more immediately useful.

Mr. G. undertakes to apply the ærostatic power to the raising or lowering of canal boats on an inclined plane, between a water level and a higher level, with or without water. He will propel boats on a high level, destitute of water, and lower them to a water level. He can raise or lower carriages on rail-ways from one level to another—relieve steam-boats stranded or grounded, &c. Combining also both ærostatic and hydrostatic powers, he can raise or lower canal boats to or from a high vertical altitude, raise vessels stranded, and other heavy bodies, from under water, also on land by means of hydrostatic cranes. He can direct how to prevent ships from sinking, &c.; and finally, he will protect or guard

steam-boats against snags, planters, sawyers, shoals and rocks. Such materials, under the protection of a national *patent right*, are well worthy of the attention of philosophers and of mechanical philanthropists. For the full illustration of this subject, plates are necessary, which, by the liberality of the proprietor, will be furnished, as far as necessary, in a succeeding number.

The views and plans of Mr. Genet are not all equally practicable, but no one of them requires more labour and comparative ingenuity than would have been foreseen to be necessary, by the first navigator of an Indian canoe, had he been told that the same might, in the progress of time, be converted into a line-of-battle ship of 124 guns.

There is a doubt, however, that may arise in the minds of many, concerning the correctness of the appellation or definition of the *upward forces of fluids*, as adopted by Mr. Genet. Indeed, any kind of matter, or fluid, which is observed to have that tendency, owes it entirely, it is believed, to *gravity*. Such is in fact the result of pressure downwards, which causes a corresponding pressure of the lighter bodies *upwards*. But on this point, let Mr. Genet speak for himself.

"In my meditations on the homogenity of the forces usually applied to mechanics, I have viewed with astonishment that the force of levity, or the upward force, should have been entirely overlooked and neglected; when Newton himself had admitted the existence of a drawing force opposed to the force of gravity, which prevents the moon from falling upon the earth; when Herschel had calculated that the force of levity, as exhibited by caloric, was such that it moved in every direction at the rate of 200,000 miles in a second; when the smoke and the vapours of the earth manifested, by their ascension through the atmosphere, that they were impelled by a force acting inversely to the force of gravity; when that same force, which chemistry has proved to be due to caloric latent or sensible, was known to be the cause of the ascension of balloons; when those ærostatic machines were seen to raise heavy weights in a different tangent from the force of gravity; when the report of the bold adventurers who raised themselves in the air, by the means of those ærostats, had testified, that equally independent of the general laws of atmospheric pressure and aerometry, the elasticity of ærostats and the accelerated motion of their ascension, increased as the

air grew lighter and the atmospheric pressure decreased; when it was also stated by them, that as they approached the upper strata of the atmosphere, perhaps occupied by an etherial gas, at the altitude of 3670 rods, the highest to which men ever have ascended, above the geological crust of the globe, the spirit of life itself seemed to be drawn upwards and to become evanescent, retaining no recollection, on its return to vital air, of what had happened during its lipothymy; and when, finally, it had been proved that the laws of gravity varied in the same body in proportion of its degree of heat or cold, as it is evinced under the equator and the colder latitudes towards the poles, by the pendulum, retarded when rendered specifically lighter and bulky *by caloric*, or accelerated when rendered heavier and contracted *by cold*."

It was a bold undertaking, that of rejecting the Newtonian solution, of the retardation of the pendulum under the equator, by the compression of the poles, and by the centrifugal force augmented by the diurnal rotation of our planet. But Mr. Genet, who is an able controversialist, establishes his philosophy upon two principles moving the universe; one is matter that seeks rest, and the other is an element that incessantly disturbs that rest; should there be one single element in the universe which cannot be controled by gravity—gravity cannot be said to be an *universal law*. At any rate, the concluding remarks on the principle *of levity*, certainly entitle the writer to the merit of consistency in his adopted denomination, of the *upward forces of fluids*.

"If motion is the result of a pressure impelled on matter at rest, it implies that the motion must be effected through some portion of space, without which no motion can be produced. If so, shall we consider that space as occupied by something or nothing? And if common sense revolts at the idea of a thing that is nothing, but a fanciful and chimerical vacuum, why should we not recognize as the occupant of that space, *caloric latent or sensible*, which emanates from the sun with the rays of light; traverses with them the immensity of space at an equal speed; insinuates itself among all the particles of matter; urges their action; converts into fluids, by its presence, all solid substances, and fluids into vapours or gas, and reproduces solids by its absence; assumes in an instant, by its combination with water, a force capable of shaking the earth, and loses it as fast as it has created it; gives levity to

ponderosity, changes the laws of gravity, and denotes, by its tendency to reascend to its centre of circulation, when it is not wanted on earth to animate nature, that gravity is not a positive, but a negative force; that it is not an active, but a passive agent; and that this mysterious and elementary fluid, which embraces all nature, under whatever name chemistry and experimental philosophy undertake to depict its infinite combinations, as caloric, electricity, magnetism or galvanism, reveals by unerring signs, its origin and its institution, evidently calculated by the great architect of the universe, to keep nature in perpetual motion. But without endeavouring to penetrate into the secret views of Providence, let us study the means of employing advantageously, the powers offered with infinite goodness to human industry; for in the end, practical utility will be found to be the best part of philosophy, and the only one which we may cultivate with pleasure and profit."

Art. X.—*Opinion on Hydrometers;* by Robert Hare, M. D. Professor of Chemistry in the University of Pennsylvania.

Pursuant to a law of Congress, the Secretary of the Treasury, being authorised to make choice of an Hydrometer, to be used in ascertaining the amount of the duties to be levied on spirits imported into the United States; a letter from the Secretary has been laid before William Jones, Esq. Professors Patterson, Keating, and myself, in which, he deputes the choice to the collector of this port, with the assistance of the naval officer, and three such persons as he may deem best qualified to judge. Being called on, under these circumstances, to give an opinion, I beg leave to premise, that, the instruments which have been heretofore employed, in the assay of spirits, have either been contrived in England, with a particular view to the duties there levied, or, have been modifications, made in this country, of instruments so contrived. Hence, none have been constructed, with a due regard to the manner in which duties are levied by our government.

Although it is more than forty years, since our political independence was achieved, we have still continued to be dependent on England for our best mathematical instruments; as it was not towards such contrivances that the enterprise of

a people settling a new country, could be advantageously or judiciously directed. Amid the many all-important objects which engrossed our rulers, during the infancy of our federal government, it cannot afford room for blame, that, while the duties on spirituous liquors have been collected, in a manner very different from that pursued in Great Britain, the employment of an instrument predicated on the practice of that kingdom, has been enjoined upon our revenue officers. But, a period of comparative leisure having now arrived, the attention of our National Legislature having been directed towards this object, and a law made, authorising the Secretary of the Treasury to choose the instrument best qualified to ensure accuracy in the assay of spirits—it appears due to the national character, that, any future selection shall be such as may bear the scrutiny of the scientific world.

The instrument now used by our custom house officers, is the hydrometer of Dicas. It consists of a bulb, with a slender stem, which have a certain ratio, in bulk, to each other. The stem being, throughout, homologous in form, and of equal dimensions, and being graduated longitudinally into equal parts. The aggregate is of such a specific gravity, as that, when placed in alcohol of the specific gravity of 800, nearly the whole of the bulb will be submerged, and all the graduated part of the stem; so that the surface of the liquid will be at 0. If placed in spirit a little weaker, a portion of the graduation of the stem will be above the surface of the liquid. The degree which coincides with this surface, being noted, opposite to the same number, on a scale accompanying the instrument, will be found the strength of the spirit, or the per centage of water more or less than would make it equal to proof spirit which is of the gravity of about .9218, and consists of nearly equal parts of water and alcohol of the specific gravity of 825.*

When the spirit is so much weaker, as to carry the whole of the graduated part of the stem above the liquid surface, a weight is added, which causes the stem to be more or less submerged. The weight used in this case is marked 10; and to this number is to be added that observed on the stem, as before. On the scale, opposite the sum thus ascertained, will be found, the per centage above or below proof.

There are thirty-six weights, so proportioned, that, supposing the instrument, in the first instance, placed in alcohol,

* According to Dr. Ure, the gravity of proof spirit, according to Dicas, is .9218. This agrees with an observation made by me, with one constructed by M. Fisher & Son, according to the plan of Dicas.

and that this alcohol were gradually reduced in strength, by the addition of water, the graduation on the stem would have to emerge thirty-six times, and be as often submerged by an additional weight; each weight differing from its predecessor, by the weight of a quantity of the spirit, equal in bulk to the ten divisions on the stem.

Alcohol varies about $\frac{1}{825}$ for every two degrees of temperature: strong spirit varies in gravity, about $\frac{1}{914}$ part for every $2\frac{1}{2}$ degrees of temperature: weaker spirit, $\frac{1}{980}$.* A thermometer accompanies the instrument, and, by means of a slide in the scale, the numbers found by means of the weights and the stem, are slid backwards or forwards, so as to lessen or increase the indication of strength, proportionably to the temperature.

If this be a correct account of Dicas' hydrometer, it will be evident, that, when well executed, it must be capable of affording correct indications; and that, any errors or inconsistencies, which may have been discovered in the results, obtained by it, may be ascribed either to incorrectness in the execution of the instrument, or to its being deteriorated by wear, by accident, or abuse. But to these sources of inaccuracy, all instruments, constructed in a similar way, are equally liable: and, while such instruments are used, I cannot conceive any other method of preventing error, than that the instruments shall all be tried by a scientific and skilful officer, before they are used, and periodically passed through his hands, for the purpose of rectification, whenever he may find it necessary.

An expectation has been excited, by the advertisement of the collector, for persons, having hydrometers, to bring them forward, that competent persons would, after a short notice, intuitively form an opinion of the comparative accuracy of the different instruments laid before them. Those who are acquainted with the subject, will perceive, that a great number of laborious experiments, and calculations, would be requisite, to do justice to any one instrument; and there are now, perhaps, ten instruments, which would each require this labour, before I should feel myself qualified to decide in a case affecting the pretensions of many ingenious artists.

But while, on the one hand, such an examination would be attended by great labour, I do not think that it would essentially promote the views of government, since the result could only determine the competency of the particular instruments

* See Gilpin's Tables.

subjected to trial. It could afford no security against the sources of error, or inconsistency, already specified, in my observations respecting the hydrometer of Dicas.

It is, obviously, only with regard to the general design of the instruments laid before me, that I could be expected to express an opinion extemporaneously. I could only say, how far one, either in its principle, or its construction, may be preferable to another: how far it may be less liable to deterioration; or, its deviations easier to discover or correct. In these respects, over the instrument already used by the government, I have not seen any superiority, in those brought into competition with it, adequate to justify a hasty change.

As the duties are now laid, it is only important to know, whether spirit is below ten per cent. under proof—above ten, and below five per cent. under proof—above five, or below proof—above proof, and below twenty per cent. over proof—above twenty, and below forty per cent. over proof. If government adheres to these rates, none of the instruments predicated on the practice of England, [where the tax is regularly in proportion to the quantity of proof spirits in the liquor] can be suited to this country; and it will be desirable to have a method of ascertaining, with accuracy, those gravities, above or below which, the duties are varied. Hence, an instrument, much more simple, and much less expensive, than those now used, might answer better.

Should the present mode of laying the duties, appear to the government, as it does to me, to be inaccurate and unjust, I would suggest, that the duty should be laid on the alcohol, of .825;* so that, in order to find the amount to be collected, it should only be requisite to multiply the number expressing the actual quantity of that liquid in the spirit, by a certain number of cents; and that, an hydrometer be so constructed, as to give the per centage of alcohol, and, at the same time, showing the coincidence of the different strengths, thus indicated, with the specific gravity, and with the strengths hitherto designated, by the per centage of water to be added or subtracted, in order to render the liquor equivalent to proof spirit.

I conceive, that there would be an advantage, in resorting to the natural standards of water and alcohol, instead of those, arbitrarily and ignorantly adopted, in the infancy of science, both as respects the equable payment of duties by the *wary* and the *unwary*, and, the precision which such a system

* This is nearly as strong as distillation will render it, and as the gravity assumed for it in Gilpin's Tables.

has a tendency to introduce, among those who manufacture or deal in spirit.

The only evidence, of the comparative eligibility of the instruments laid before me, which was adduced in a form to which I feel myself justified in listening, was that of Mr. Jackson, one of the revenue officers of this port; on whose judgment and testimony, I place great reliance. This officer appears to prefer the instrument to which he has been accustomed; and he demonstrated, that there was no inconvenience in the use of it, adequate to justify its being exchanged for the hydrometers of Southworth, or Tucker, which were the only instruments placed in competition with it. Had not the hydrometer of Dicas been already employed, I should not have preferred it to that of Tucker, which appears analogous in principle, and is apparently very well made. The hydrometer of Southworth, although in design and execution, apparently less perfect than the other, for the purposes of manufacturers and dealers, is recommended by its simplicity. It has only one weight; and, in most cases, will answer, without any change of weight. The corrections for temperature, are made by adding or subtracting 1½ degrees for every five degrees of temperature.

To conclude; I am of opinion, that, in order that a proper decision should be made, respecting the most advantageous plan to be adopted by government, in assaying spirit, time should be allowed, to those to whom the question is referred; and that they should be authorized to incur a reasonable expense, in the requisite investigations.

I have been for some time engaged, in ascertaining the merits of some methods of determining gravities, which are altogether new. I intend, shortly, to lay the result before the public.

Although it is possible, that, in practice, unforeseen objections to these new instruments may arise; I have no hesitation in saying, that they possess a very important characteristic, that of being so simple and obvious, in the principle of their construction, that they may be tested at any time, by a pair of compasses or a scale beam; and that, like the last mentioned instrument, they furnish a mean of determining the value of the article, easily comprehended and estimated, by those who are interested in the result: whereas the hydrometers, now used, afford indications, which must be taken upon trust, especially by the inexperienced.

ART. XI.—*Notice of a brilliant Meteor seen at Burlington, Vt. on the evening of April* 14; in a letter to the Editor from GEORGE W. BENEDICT.

THIS meteor was seen by Dr. Henry S. Waterhouse, about a mile south of Burlington. It disappeared at twenty minutes past eleven.

Its altitude* above the horizon, when first seen, was 9°, 48′, 20″; its azimuth, as observed, was north 49°, 30′ east, or, deducting 7°, 36′ for the variation of the needle, its azimuth would be north 41°, 54′ east. Its altitude when it went out of sight, behind a ridge of land, was 3°, 6′, 20″, and its corrected azimuth north, 26°, 57′ east. The place of observation is in N. latitude 44°, 26′, and in longitude 73°, 15′ west from Greenwich.

From its apparent magnitude to Dr. W. compared with that of the meridian sun, it must, on its first appearance, have subtended an angle of about 7 minutes, which, from a similar comparison, must have been enlarged to about twenty-eight minutes by the time of its leaving his sight. He remarked, that it seemed to him to undergo a *sudden* enlargement, at two different times, rather than a gradual one from first to last. Its tail was, at first, very small; indeed, there was scarcely any; but it increased in magnitude and splendor with great rapidity, so that when the ball went below the hill, the length of the tail was apparently equal to twenty or thirty times the diameter of the globe itself. No sparks were seen: the tail passed gradually out of sight in the direction of the main body. The light seemed equal to that of mid-day: no report was heard. Dr. W. judged the time from its first appearance till the ball went out of his view, to be two and a half seconds, and till the tail had wholly vanished, four seconds.

These observations lead to a conclusion that it must have passed over a line very *far* to the north of this place.

The impression on the mind of Dr. W. at the time was, that its course was nearly northwest; but of course nothing can be known on this point save with the aid of other observations, to which this notice may be auxiliary.

* From its direction across the tops of certain trees of very marked character, he was enabled to designate positions in its path, with a precision unusual in such phenomena. The necessary angles were taken by J. Johnson, Esq. of this village, and myself, with an excellent theodolite.

ART. XII.—*On Specific Gravity.* By ROBERT HARE, M. D. Professor of Chemistry in the University of Pennsylvania.

A CLEAR conception of Specific Gravity, is necessary, to a comprehension of the language of the most useful sciences and arts. It may be defined, the ratio of the weight of a body, to its bulk.

On the means of ascertaining Specific Gravities.

The object of all the processes for this purpose, is, either to ascertain the weight of known bulk, or the bulk of known weight. When masses are reduced to the same bulk, it is only necessary to weigh them. When they are reduced to the same weight, it is only necessary to measure them. If water were among a number of substances reduced to the same bulk, and weighed, and its weight assumed as a unit, the numbers found, would be the same as those now in use to express specific gravities. The gravity of water has been assumed as the standard, because this fluid may almost always be had, sufficiently pure; and it is generally easy to ascertain the weight of a quantity of it, equal, in bulk, to any other body.

In order to obtain the specific gravity of a body, therefore, we have only to divide its weight, by the weight of a quantity of water equal to it in bulk.

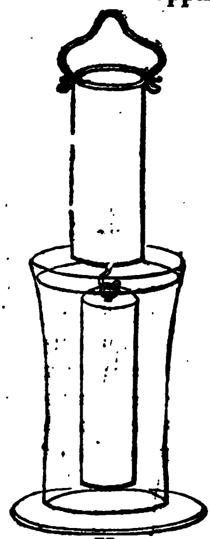
The weight of a quantity of water, equal to the body in bulk, is equal to the resistance which the body encounters in sinking in water. Hence, if we can ascertain, in weight, what is necessary to overcome the resistance which a body encounters in sinking in water, and divide, by this weight, thus ascertained, the weight of the body, we shall have its specific gravity.

In the case of a body which will sink of itself, the resistance to its sinking, is what it loses of its weight, when weighed in water.

In the case of a body which will not sink of itself, the resistance to its sinking, is its weight added to the weight which must be used to make it sink.

Experimental Demonstration, that the resistance which a body encounters, in sinking into any fluid, is just equivalent to the weight of a portion of the fluid, equalling the body in bulk.

This proposition may be experimentally* demonstrated, by means of the apparatus, represented by the following figure.



V

The cylinder, represented as surrounded by the water of the vase, (V) is made to fit the cavity of the cylinder suspended over it so exactly, as that it enters the cylinder with difficulty, on account of the included air, which can only be made to pass by it slowly. It must, therefore, be evident, that the cavity of the hollow cylinder, is just equal in bulk to the solid cylinder, which so exactly fits it.

Both cylinders, (suspended as seen in the plate) being counterpoised accurately upon a scale beam; let a vessel of water be placed in the situation of the vase, in the drawing. It must be evident, that the equiponderancy will be destroyed, since the solid cylinder will be buoyed up by the water. If water be now poured into the hollow cylinder, it will be found, that, at the *same* moment *when* the cavity becomes full, the equiponderancy is restored, and the solid cylinder sunk just below the surface of the water.

It therefore appears, that the resistance which the solid cylinder encounters, in sinking in the water, is overcome by the weight of a quantity of the water equal to it in bulk. It must be evident, that the same would be true of any other body, and of any other fluid.

Rationale.

When a solid body is introduced into an inelastic solid, on withdrawing it, a hole is left, which remains vacant of the

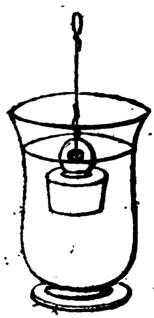
* Although there may be some novelty in the method in which specific gravity is treated of in the first three pages, the matter is not offered, as original; nor would have been deemed worthy of publication, unless as accompanying and illustrating the instruments afterwards described.

solid matter: but, no sooner is a body, which has been introduced into a liquid, withdrawn, than the liquid is found to fill up the space from which it has been removed.

It is evident, that the force which liquids exert, thus to reenter any space within them, from which they are forcibly displaced, is precisely equal to the weight of a quantity of the liquid, commensurate with that space; since, when the space is re-occupied by the liquid, the equilibrium is restored. Consequently, every body, introduced into a liquid, experiences from it a resistance equal to the weight of a quantity of the liquid, commensurate with the cavity, which would be produced, supposing the liquid, frozen about the solid mass, split open so as to remove it, and the fragments put together again: and the cavity also thus created, must obviously be exactly equal to the bulk of the body. It follows, that the resistance which any body encounters in sinking, within a fluid, is equivalent to the weight of a quantity of the fluid, in bulk equal to the body.

To ascertain the specific gravity of a body heavier than water.

Let the body be the glass stopple, represented in the following figure.



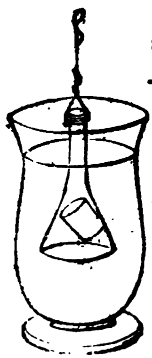
First counterpoise the stopple by means of a scale beam and weights, suspending it by a fine metallic wire. Place under the stopple, a vessel of pure water, and lower the beam, so that, if the stopple were not resisted by the water, it would be immersed in that fluid. Add just as much weight, as will counteract the resistance which the water opposes to the immersion of the stopple, and render the beam again horizontal. Divide the weight, by which the stopple had been previously counterpoised, by the weight thus employed to sink it. The quotient will be the specific gravity.

Rationale.

The weight required to sink the stopple, is equal in weight to the bulk of water which the stopple displaces. Of course, pursuant to the general rule, it is only necessary to see how

often this weight is contained in the weight of the stopple, to ascertain the specific gravity.

To ascertain the specific gravity of a body lighter than water.



Let a small glass funnel be suspended from a scale beam, and counterpoised so as to be just below the surface of some water in a vase, as in this diagram.

If, while thus situated, a body lighter than water, a small cork, for instance, be thrown up under the funnel, the equilibrium will be subverted. Ascertain how much weight will counteract the buoyancy of the cork, add this to its weight, and divide its weight by the sum—the quotient is the answer.

Rationale.

The force with which the cork rises against the funnel, is equal to the difference between its weight and the weight of the bulk of water which it displaces. Of course, ascertaining the force with which it rises, by using just weight enough to counteract it, and adding this weight, so ascertained, to that of the cork, we have the weight of a bulk of water, equal to the bulk of the cork. By this, dividing the weight of the cork, agreeably to the general rule, the specific gravity of the cork will be found.

To ascertain the specific gravity of a Liquid.

Let the stopple be counterpoised, exactly as in the last experiment, excepting that it is unnecessary to take any account of the counterpoising weight.

Having, in like manner, ascertained how much weight will sink it in the liquid, divide this by the weight required to sink it in water, as above. The quotient will be the specific gravity sought.

Rationale.

It has been proved, that the resistance to the sinking of a body in any fluid, is precisely equal to the weight of a bulk of the fluid, equal to the bulk of the body. Ascertaining the

resistance to the immersion of the same body in different fluids, is, therefore, the same as ascertaining the weights of bulks of those fluids, equal to the body, and, of course, to each other. And if one of the liquids be water, dividing by its weight, the weight of the others, gives their specific gravities.

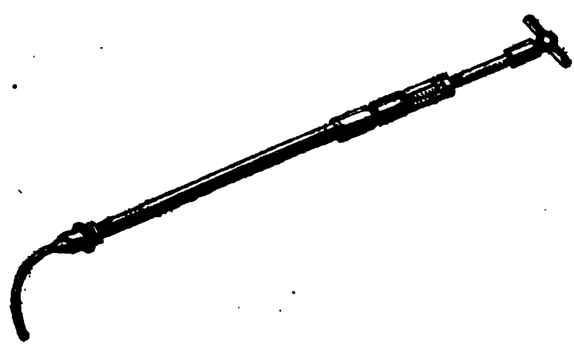
If the stopple be so proportioned, as to lose just one thousand grains, by immersion in water, division is unnecessary, as the weight of the liquid will be obtained in grains, which are thousandths by the premises. A metallic mass, of the same weight as the stopple exactly, may be employed as its counterpoise.

In these experiments, the liquid should be as near 60° of Fahrenheit's Thermometer as possible.

On the application of the Sliding Rod measurement, in Hydrometry.

There is, in my opinion, no mode of measuring fluids, heretofore contrived, so accurate and convenient, as that which I have employed in my Eudiometers. I allude to the contrivance of a rod, or piston, sliding through a collar of leathers into a tube, and expelling from it any contained fluid, in quantities measured by degrees marked upon the rod; and ascertained, with additional accuracy, by means of a vernier.

One of the most advantageous applications of the mechanism alluded to, is, in ascertaining specific gravities, in the case either of liquids or solids. To assay liquids which are not corrosive, I have employed two instruments like that represented in the following figure, severally graduated to 100 degrees, and furnished with a vernier, by which those degrees may be divided into tenths, and each scale made equivalent to 1000 parts.



In order to avoid circumlocution, I shall, to the instrument here represented, give the name of *Chyometer;* from the Greek, *chuo*, to pour, and *meter*, measure.

Supposing two such instruments to be filled, to the extent of the graduation, one with pure water, the other with any spirituous liquid, lighter than water, whose gravity is to be found; let 1000 parts of the liquid be excluded into one scale of a beam, and then exclude into the other scale as much water as will balance it. Inspecting the graduation of the Chyometer, from which the water has been expelled, the numbers observed, will be the answer sought. For, supposing 1000 measures of alcohol were placed in one scale, if 800 measures of water counterbalance it, the alcohol must be to the water, in gravity, as 800 to 1000; since it is self-evident, that when any two masses are made equal in weight, their gravities must be inversely as their bulks.

To ascertain the specific gravity of a Solid, by the Chyometer.

For this purpose, the body, whose gravity is in question, should be suspended in the usnal way, beneath one of the scales of a balance, and its weight, in parts of water, at 60° F. ascertained, by measuring from the Chyometer, into the opposite scale, as many parts as will balance the body. Being thus equipoised, and a vessel of pure water, at the same temperature as that introduced by the Chyometer, duly placed under it; the number of parts of water, competent exactly to cause it to be merged in this fluid, will be the weight of a quantity of water, equivalent in bulk to the body. Of course, dividing, by the number thus observed, the weight of the body, in parts of water as previously found, the quotient will be the specific gravity.

This process ought to be easily understood, since it differs from the usual process only, in using measures of water, instead of the brass weights, ordinarily employed.

The Chyometer enables us to make new weights, out of water, for each process.

To ascertain the specific gravity of a Corrosive Fluid, by the Chyometer.

The process, described in the preceding page, is only applicable, where the fluid is not of a nature to act upon the

sliding rod. By employing a body—a glass bulb, for instance—appended from a balance, as in the usual process, we may use water, measured by the Chyometer, in lieu of weights.

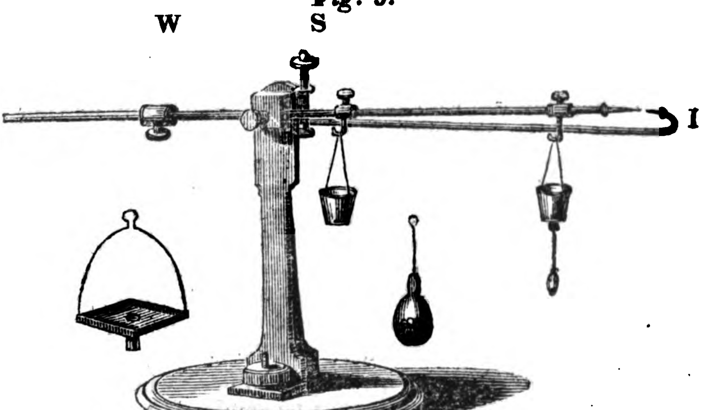
First, having counterbalanced the body exactly, ascertain how many parts of water will cause it to sink in water; next, how many parts will cause it to sink in the liquid, whose gravity is to be ascertained. The number last found, being divided by the first, the quotient is the specific gravity.

Supposing that the graduation be made to correspond with the size of the bulb, so that 1000 parts of pure water will just sink the bulb in another portion of the same fluid; the process for any other liquid, will be, simply, to ascertain how many parts of water will sink the globe in it. The number observed, will be the specific gravity; so that recourse to water, or to calculation, would be unnecessary.

The rationale of this last mentioned process, is given, in the case of ascertaining the gravity of liquids, by the glass stopple, weighing 1000 grains.—(See page 123.)

To find the specific gravity of a Mineral, without calculation, and without degrees.

Fig. 5.



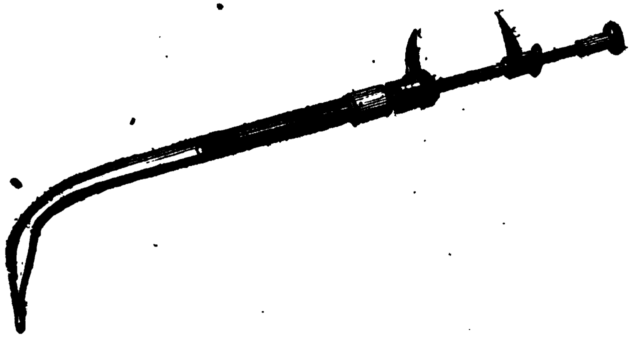
The preceding figure represents a balance employed in this process. It is, in two respects, more convenient than a common balance. The moveable weight on one of the arms, renders it easier to counterpoise bodies of various weights;

and, the adjustment of the index (I) by the screw (S) to the beam, saves the necessity of adjusting the beam to the index; the accurate accomplishment of which, by varying the weights, is usually a chief part of the trouble of weighing.

One of the buckets, suspended from the beam, is five times as far from the fulcrum as the other.

A chyometer is employed in this process, of which the following figure will convey a correct idea.

B



The rod of this instrument is not graduated, but is provided with a band, (B) which can be slipped along the rod, and fastened to any part of it by means of a screw.

Let a mineral be suspended from the outer bucket, and rendered equiponderant with the counter-weight, (W) by moving this further from, or nearer to the fulcrum, so that the index point (I) may be exactly opposite the point of the beam. Place under the mineral a vessel of water, and add as much of this fluid to the bucket, by means of the chyometer, as will cause the immersion of the mineral. The band (B) which is made to slip upon the rod, should be so fastened, by means of the screw, as to mark the distance which the rod has entered, in expelling the water, requisite to sink the mineral. Having removed the vessel of water, and the mineral, ascertain how many times the same quantity of water, which caused the immersion of the mineral, must be employed to compensate its removal.

Adding to the number thus found, one for the water, (previously introduced into the bucket, in order to cause the immersion of the mineral,) we have its specific gravity; so far as it may be expressed without fractions. When requisite, these

may be discovered by means of the second bucket, which gives fifths for each measure of water; which, if added to the outer bucket, would be equivalent to a whole number. By the eye, the distance is equally so divided, as to give half fifths, or tenths. Or, the nearest bucket, being hung one half nearer the fulcrum, the same measures will become tenths in the latter, which would be units, if added to the outer bucket.

Rationale.

The portion of the rod, marked off by the band, was evidently found competent by its introduction into the tube of the chyometer, to exclude from the orifice a weight of water, adequate to counteract the resistance encountered by the mineral in sinking in water: consequently, agreeably to the general rule,* to find the specific gravity of the mineral, we have only to find how often this weight (of water) will go into the weight of the mineral—or, what is the same in effect, how often the former must be taken, in order to balance the latter. Indeed, it must otherwise, be sufficiently evident, that the mineral and the water being made equal in weight, their specific gravities must be inversely as their bulks, which are known by the premises.

The inner bucket may be dispensed with, and greater fractional accuracy attained, by means of a sector, graduated into 100 parts. It is for this purpose that the sliding band, and the ferrule at the but-end of the tube, are severally furnished with the points. The assistance of a sector is especially applicable, where fluids are in question, since it is necessary to find their differences in thousandths.

To find the specific gravity of a liquid, by the Sectoral Chyometer.

Let a glass bulb, (represented in figure 5, under the buckets,) be suspended from the outer bucket, and counterpoised. Let the situation of the beam be marked, by bringing the point of the index opposite to it. Let the tube of the chyometer be full of water, and the rod retracted, until stopped by an enlargement purposely made at its inner termination. Next return it into the tube, until as much water is projected into the bucket, as is just adequate to cause the immersion of

* See page 121.

the bulb. Let the band be fastened upon the rod, close to where it enters the tube, so as to mark the extent to which it may have entered. The rod must, in the next place, be drawn out from its tube, to its first position; and the sector so opened, as that the points may extend from 100 degrees on one leg to 100 upon the other. Leaving the sector thus prepared, place under the suspended ball, a vessel containing an adequate quantity of the fluid, whose gravity is required. If the fluid be lighter than water, in order to cause the immersion of the bulb in it, the rod will not have to enter so far as at first. This distance being marked, by fixing the sliding cylinder, and the rod withdrawn from the tube as far as allowed by the stop, the number on each leg of the sector, with which the points will coincide, gives the gravity of the fluid. Forcing as much water into the bucket as had been sufficient to sink the bulb in water, will not sink it in a heavier liquid; consequently, in the case of such liquids, it will be necessary to fill the chyometer a second time, and force as much more water from it, as may be sufficient to cause the immersion of the bulb. The sliding band being then fixed, and the points separated and applied to the sector, as before, the number to which they extend must be added to the weight of water =100, for the specific gravity of the fluid in question.

Small differences are better found by subtraction; as, for instance, suppose the specific gravity of the fluid were 101; after the small addition of water made to the bucket, beyond the 100 parts required for the immersion of the bulb *in water*, (the band being unmoved,) the points would extend from 99 on one leg, to 99 on the other. The difference between this number, and 100, is then to be added to the weight of water; so that the specific gravity is found to be 101.

The angle made by the sectoral lines in using the same bulb, and the same rod, will always be the same. Hence a stay may be employed to give the sector the requisite opening.

Indeed, were liquids alone in question, an immovable sectoral scale would answer. Thus prepared, it were unnecessary to have recourse to water, excepting in the first adjustment of the scale. The number of parts, required to merge the bulb in any fluid, will reach (at once or twice) the number, or numbers, on the sector, which give the required gravity.

In this process, if greater accuracy be desirable, it is only necessary to employ a smaller rod, or a larger bulb. Instead

of effecting an immersion, by one stroke of the rod, it may be done by ten strokes, which will make each division of the sector indicate a thousandth of the bulk of the bulb.

The following process is, however, preferable, as the sector is made to give the answer in thousandths, without the delay of filling and emptying the chyometer more than once.

Let the distance on the rod of the chyometer be ascertained; which, when introduced five times successively, will exclude just water enough to overcome the resistance encountered by a globe, in sinking in that fluid. Let the sector be opened, to the distance so designated; let the globe be partially counterpoised, so as to float in any liquid heavier than 800. The apparatus being thus prepared, if the globe be placed in a liquid, in which it floats, add as much water, from the chyometer, to the scale, from which it hangs, as will sink it—and by means of the points and the sector, ascertain the value of the distance to which the rod has been introduced. Adding the numbers, thus found, to 800, the sum will be the specific gravity of the liquid.

For this process, the sector should be divided into 200 parts, and, the proper opening being once duly ascertained, should be preserved, by means of an arc, like that attached to common beam compasses.

Instead of a globe, a hydrometer, surmounted with a cup, may be employed, either with a graduated, or a sectoral, chyometer.

In lieu of having points attached to the chyometer, as represented in the figure, it may be as convenient to have two small holes, for the insertion of the points of a pair of compasses, either of the common kind, of the construction used by clock makers, or that which is known under the name of beam compasses.

The compasses may be used to regulate the opening of the sector, or to ascertain, by the aid of that instrument, the comparative value of the distances which the rod of the chyometer has to be introduced into its tube.

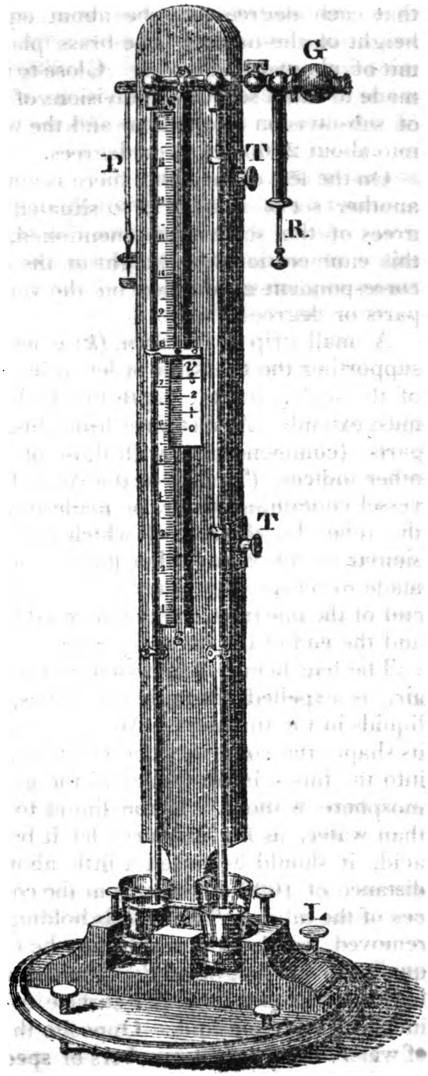
In order to convey an idea of the nature of the sector, to any reader who may be unacquainted with it, I trust it will be sufficient to point out, that its construction is similar to that of the foot-rule used by carpenters. We have only to suppose such a rule, covered with brass, and each leg graduated into 200 equal parts, in order to have an adequate conception of the instrument employed by me.

A more particular explanation of the principle of the sector, may be found in any Encyclopedia, or Dictionary of Mathematics.

Before taking leave of the reader, it may be proper to explain the use of the square dish, which may be seen to the left, under the beam, (figure 5.) The arc of wire, is for the purpose of suspending the dish to the hook, in place of the outer bucket. When so suspended, filled with water, and duly balanced, it will be found soon to become sensibly lighter, in consequence of the evaporation of the water. By means of the chyometer, it is easy to ascertain the different quantities evaporated, in similar times, and at different periods, and in different places; so that, guarding against the effects of aerial currents, hydrometrical observations may be made with great accuracy.

ON THE LITRAMETER.

This name is derived from the Greek *litra*, weight, and *meter*, measure; and is given to one of the instruments which I have contrived for ascertaining specific gravities. The litrameter owes its efficiency to the principle, that when columns of different liquids are elevated by the same pressure, their heights must be inversely as their gravities.



Two glass tubes, of the size and bore usually employed in barometers, are made to communicate internally, with each other, and with a gum elastic bag, (G) by means of a brass tube and two sockets of the same metal, into which they are severally inserted. The brass tube terminates in a cock, to which the neck of the bag is tied. Between the cock and the glass tubes, there is a tube at right angles to, and opening into, that which connects them. At the lower end of this tube, a small copper rod (R) enters through a collar of leathers,

The tubes are placed vertically, in grooves, against an upright strip of wood, tenanted into a pedestal of the same material. Parallel to one of the grooves, in which the tubes are situated, a strip of brass is fastened; and graduated, so that each degree may be about equal to $\frac{1}{11}$, of the whole height of the tubes. The brass plate is long enough to admit of about 140 degrees. Close to this scale, a vernier (*v*) is made to slide, so that the divisions of the scale are susceptible of sub-division into tenths, and the whole height of the tubes into about 2200 parts, or degrees.

On the left of the tube, there is another strip of brass, with another set of numbers, so situated as to comprise two degrees of the scale above-mentioned, in one. Agreeably to this enumeration, the height of the tubes is, by the aid of a correspondent graduation on the vernier, divided into 1100 parts or degrees.

A small strip of sheet tin, (*k*) is let into a kerf in the wood, supporting the tubes, in order to indicate the commencement of the scale, and the depth to which the orifices of the tubes must extend. At distances from this, of 1000 parts and 2000 parts, (commensurate with those of the scale) there are two other indices, (T, T,) to the right hand tube. Let a small vessel containing water, be made to receive the lower end of the tube, by the side of which the scale is situated; and a similar vessel of any other fluid, whose gravity is sought, be made to receive the lower end of the other tube; so that the end of the one tube, may be covered by the liquid in question, and the end of the other tube, by the water.

The bag being compressed, a great part of the contained air, is expelled through the tubes, and rises through the liquids in the tumblers. When the bag is allowed to resume its shape, the consequent rarefaction allows the liquids to rise into the tubes, in obedience to the greater pressure of the atmosphere without. If the liquid to be assayed, be heavier than water, as for instance, let it be concentrated sulphuric acid, it should be raised a little above the first index, at the distance of 1000 degrees from the common level of the orifices of the tubes. The vessels holding the liquids, being then removed, so that the result may be uninfluenced by any inequality in the height of the liquids, the column of acid must be lowered, until its upper surface coincide exactly, with the index of one thousand. Opposite the surface of the column of water, the two first numbers of specific gravity of the acid,

will then be found; and, by duly adjusting and inspecting the vernier, the third figure will be ascertained. The liquids should be at the temperature of sixty.

If the liquid under examination, be lighter than water, as in the case of pure alcohol, it must be raised to the upper index. The column of water, measured by the scale of 1000, will then be found at 800 nearly; which shows that 1000 parts of alcohol, are in weight, equivalent to 800 parts of water—or in other words, 800 is ascertained to be the specific gravity of the alcohol.

The sliding rod and tube at R, between the cock and the glass tubes,* facilitates the adjustment to the index, of the column of liquid in the right hand glass tube. When the rod is pushed in as far as possible, it causes a small leak, by which the air enters; and the columns of the liquids, previously raised too high by the bag, may be allowed to fall, till the liquid which is to be assayed, is near the index. Then, by pushing the rod in, they may be gradually lowered, and adjusted to the proper height with great accuracy.

A rod of this kind, graduated, might answer the purpose of a vernier.

The bag of Caoutchouc, may be advantageously furnished with two valves; one opening from the tubes into the bag, the other, from the bag into the air.

But upon the whole, I find a syringe preferable; the adjusting rod being included in the rod of the piston, which is perforated for its reception, and furnished with a stuffing box, to render it air tight.

The plummet P, and the screws at L, enable the operator to detect, and rectify any deviation, in the instrument, from perpendicularity.

An account of the Hydrostatic Blowpipe, as now used in the Laboratory of the University of Pennsylvania.

The following passage is quoted from a memoir on the supply and application of the Blowpipe, which I published in 1802:—

"The blowpipe is, on many occasions, a useful instrument to the artist and philosopher. By the former, it is used for the purpose of enamelling, to soften or solder small pieces of metal, and for the fabrication of glass instruments; while the

latter can, by means of it, in a few minutes, subject small portions of any substance, to intense heat; and is thus enabled to judge of the advantage to be gained, and the method to be pursued, in operations on a larger scale. It is by means of the blowpipe, that glass tubes are most conveniently exposed to the heat necessary to mould them into the many forms occasionally required, for philosophical purposes; and by the various application of tubes, thus moulded, ingenuity is often enabled to surmount the want of apparatus; which is the greatest obstacle to the attainment of skill, in experimental philosophy.

"To all the purposes which I have mentioned, the blowpipe is fully adequate, when properly supplied with air, and applied to a proper flame: but it appears that the means which have hitherto been employed to accomplish these ends, are, more or less, defective.

"The most general method, is that of supplying this instrument with the breath. In addition to the well known difficulty of keeping up a constant emission of air during respiration, and its injurious effect upon the lungs,* it may be remarked, that as the breath is loaded with moisture, and partially carbonized, it is proportionably unfit for combustion; and the impossibility of supporting a flame with oxygen gas, by this method, is obvious.

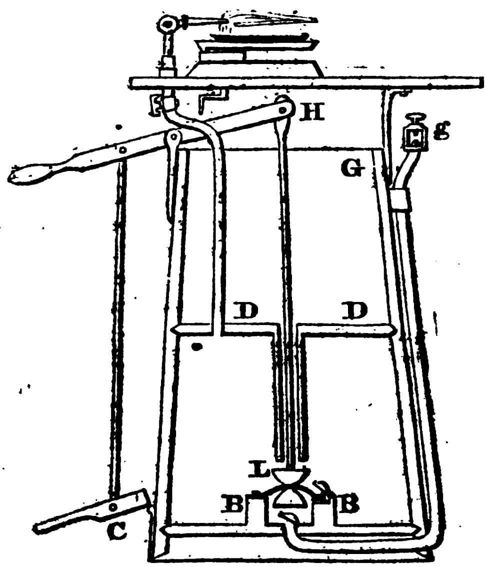
"Another way of supplying the blowpipe with air, is that of connecting with it a small pair of double bellows. A contrivance of this kind, possesses obvious advantages over the mouth blowpipe; but, owing to the pervious nature of the materials of which bellows are constructed, and the difficulty of making their valves air tight, the greater part of the air drawn into them, escapes at other places than the proper aperture. A pair of bellows, of this kind, belonging to an artist of this city, which were not considered as less air tight than usual, were found to discharge the complement of their upper compartment, in six-sevenths of the time, when the orifice of the pipe was open, which was requisite when it was closed. Hence it appears that six-sevenths of the air ejected into the upper compartment, escaped at other places than the proper aperture; and if to this loss were added that sustained by the lower compartment, the waste would be much greater. As in operating with these machines, it is necessary constantly to move the foot, the operator cannot leave his

* In consequence of this, some artists have abandoned the use of the instrument.

seat; and in nice operations, the motion of his body is an inconvenience, if not a source of failure. Bellows of this kind cannot be used for supplying combustion with oxygen gas; because, as this air is only to be obtained by a chemical process, it is very desirable to avoid any waste of it; and, as there is always a portion of air remaining in them, even when the boards are pressed as near to each other as the folding of the leather will permit, any small quantity of oxygen gas, which might be drawn into them, would be contaminated.

"Being sensible of the advantage which would result from the invention of a more perfect method of supplying the blowpipe with oxygen gas or atmospheric air, I was induced to search for means of accomplishing this object. The result of my attention to the subject, is the production of a machine, of which there follows an engraving and description."

The machine, which the following figure represents, does not differ essentially from that alluded to in the passage above quoted. The construction is, however, more simple and easy.



Explanation of the figure.

The *Hydrostatic Blowpipe* consists of a cask, divided by a horizontal diaphragm, into two apartments (DD.) From

the upper apartment, a pipe of about three inches in diameter, (its axis coincident with that of the cask,) descends until within about six inches of the bottom. On this is fastened by screws, a hollow cylinder of wood, (BB,) externally twelve inches, internally eight inches, in diameter. Around the rim of this cylinder a piece of leather is nailed, so as to be air tight. On one side, a small groove is made in the upper surface of the block, so that when nailed, a lateral passage may be left under the leather, on each side of the groove. This lateral passage communicates with a hole bored vertically into the wood, by a centre-bit; and a small strip of the leather, being extended so as to cover this hole, is made, with the addition of some disks of metal, to constitute a valve opening upwards. In the bottom of the cask, there is another valve, opening upwards. A piston rod, passing perpendicularly through the pipe, from the handle (H,) is fastened near its lower end, to a hemispherical mass of lead (L.) The portion of the rod beyond this, proceeds through the centre of the leather, which covers the cavity formed by the hollow cylinder; also through another mass of lead like the first, which being forced up by a screw and nut, subjects the leather, between it and the upper leaden hemisphere, to a pressure sufficient to render the juncture air tight. From the partition, an eduction pipe is carried under the table, where it is fastened, by means of a screw, to a cock which carries a blowpipe; so attached by a small swivel joint, as to be adjusted into any direction which can be necessary. A suction pipe passes from the opening covered by the lower valve, under the bottom of the cask, and rises vertically, close to it on the outside—terminating in a gallows (g,) for the attachment of any flexible tube which may be necessary.

The apparatus being thus arranged, and the cask supplied with water, until the partition is covered to the depth of about two inches; if the piston be lifted, the leather will be bulged up, and will remove in some degree, the atmospheric pressure from the cavity beneath it; consequently, the air must enter through the lower valve, to restore the equilibrium. When the piston is depressed, the leather being bulged in the opposite direction, the cavity beneath it is diminished, and the air being compressed, forces its way through the lateral valve into the lower apartment of the cask. This apartment being previously full of water, a portion of this fluid is pressed up through the pipe, into the upper apartment. The same re-

sult ensues every time that the stroke is repeated; so that the lower apartment soon becomes replete with air, which is retained by the cock until its discharge by the blowpipe is requisite.

The cock being opened, the air confined in the lower apartment is expelled by the pressure of the water in the upper apartment, which, as the air which had displaced it escapes, descends and re-occupies its former situation. The piston is worked either by the handle or the treadle, at C.

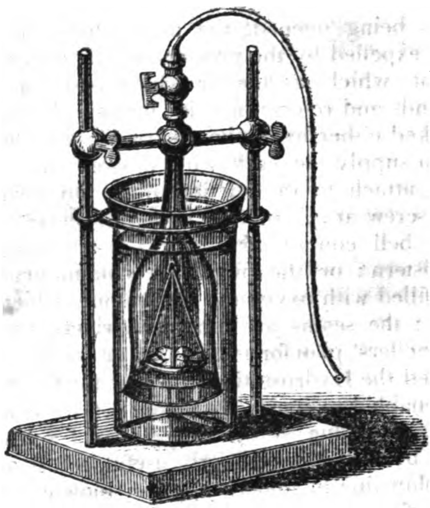
In order to supply the cask with oxygen gas, it is only necessary to attach to the suction pipe, (by means of the gallows and screw at g,) another pipe, duly flexible, and passed under a bell containing the gas in question, over the pneumatic cistern: or the pipe may communicate with a leather bag, filled with oxygen. I have one, which will hold fifty gallons; the seams are closed by rivets, agreeably to Pennock & Sellers' plan for mail-bags, or fire-hose.

Having used the Hydrostatic Blowpipe for five and twenty years, I am enabled to speak in favour of its conveniency, with the confidence due to this long trial. I am persuaded, that it would be found exceedingly useful, to all artists who employ the blowpipe in soldering, or in blowing, or moulding the tubes of thermometers, barometers, and other processes, to which the enameller's lamp is applied.

Associated with the large self-regulating reservoir of hydrogen, to be described in page 140, it is, with the aid of a jet of atmospheric air, supplied to it in the compound blowpipe, competent to fuse platina; and the facility with which the hydro-oxygen flame thus produced, may be made to act in any convenient direction, would render it highly serviceable to silversmiths, coppersmiths, and pewterers. In soft soldering, it is often far more efficacious than in soldering iron. Its peculiar cleanliness is worthy of attention; in this respect, it greatly excels the ordinary blowpipe flame. Besides, in this instrument the limits are peculiarly ample, within which the flame is susceptible of an instantaneous increase, or diminution, in size, or intensity.

I do not believe the heat produced in this way, to be much more expensive than that produced by a lamp.

Self-regulating Reservoir, for Hydrogen and other Gases, as used in the Chemical Laboratory of the University of Pennsylvania.



The preceding figure, represents a self-regulating reservoir for hydrogen gas, (whether pure or sulphuretted ;) or for nitric oxide, or carbonic acid gas.

This very perspicuous engraving, requires but little to be said in explanation of it. Suppose the glass jar without, to contain diluted sulphuric acid; the inverted bell, within the jar, to contain some zinc, supported on a tray of copper, suspended by wires, of the same metal, from the neck of the bell. The cock being open, when the bell is lowered into the position in which it is represented, the atmospheric air will escape, and the acid, entering the cavity of the bell, will, by its reaction with the zinc, cause hydrogen gas to be evolved rapidly. As soon as the cock is closed, the hydrogen expels the acid from the cavity of the bell ; and consequently, its reaction with the zinc is prevented, until there be reason for drawing off another portion of the gas. As soon as this is done, the acid re-enters the cavity of the bell, and the evolution of hydrogen is renewed, and continued until again arrested, as in the first instance, by preventing its escape, and consequently causing it to displace the acid from the interior of the bell, within which the zinc is suspended.

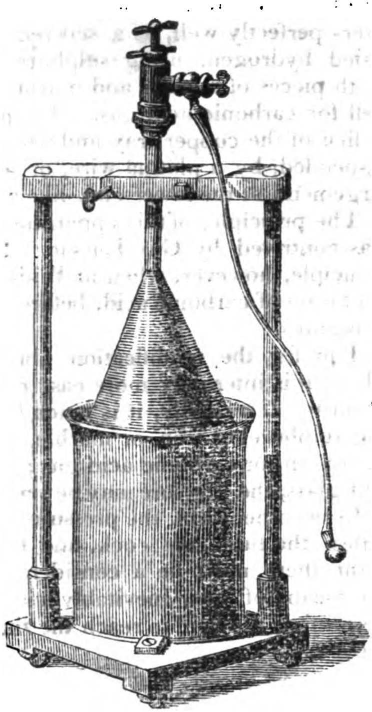
This apparatus, in the same form as here represented, answers perfectly well, as a self-regulating reservoir of sulphuretted hydrogen, using sulphuret of iron instead of zinc. With pieces of marble and muriatic acid, it answers equally well for carbonic acid gas. To qualify it for nitric acid gas, in lieu of the copper tray and wires, a coil of copper may be suspended, by a platina wire, or a glass tube, having an enlargement, at the lower end, like a nail head.

The principle, of this apparatus, is analogous to that which was contrived by Gay Lussac. I had employed the same principle, however, when at Williamsburgh, to moderate the evolution of carbonic acid, before I had read of Gay Lussac's apparatus.

I prefer the modification above described. In the first place, it is internally more easy of access, for the purpose of cleansing: secondly, it is much better qualified for containing sulphuret of iron, or marble, for generating sulphuretted hydrogen, or carbonic acid gas; and thirdly, by raising the bell glass, the pressure may be removed,

In the other form, the pressure on the gas is so great, that, unless the tube, the cock, and their junctures, be perfectly tight, there must be a considerable loss of materials; since the escape of gas, inevitably causes their consumption, by permitting the acid to reach the zinc, or other materials employed,

Large Self-Regulating Reservoir, for Hydrogen, as used in the Laboratory of the University of Pennsylvania.

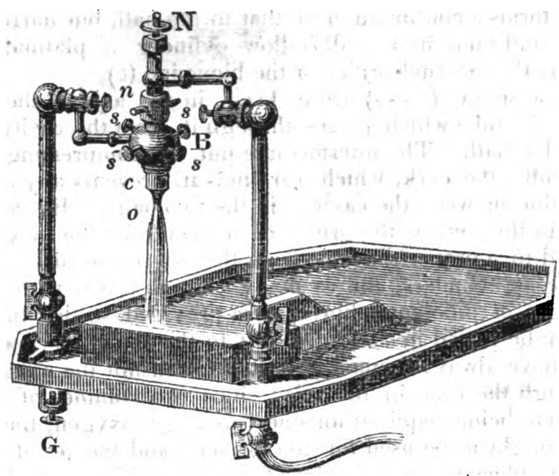


This figure, represents a self-regulating reservoir, for hydrogen gas; it is constructed like that described in the preceding chapter, excepting, that it is about 50 times larger, and is made of lead, instead of glass.

This reservoir is attached to the compound blowpipe, in order to furnish hydrogen; and may, of course, be used in all experiments, requiring a copious supply of that gas. When this is to be applied to the hydro-oxygen, or compound blow-pipe, (figured and described in the next article) the knob at the end of the pipe, which has an orifice on one side, is placed under the gallows, (G) and fastened air tight to the pipe of that instrument, by the pressure of the screw of the gallows.

Engraving and description of a Compound, or Hydro-oxygen Blowpipe used in the laboratory of the University of Pennsylvania.

The following figure represents a compound blowpipe, which I contrived and executed myself, about eleven years ago; but, fearing it might be deemed unnecessarily complex, I have never published any account of it. Experience has shown, that the complication of its structure, does not render it more difficult to use, than the simplest instruments



intended for the same purpose; while its parts are peculiarly susceptible of advantageous adjustment.

B is a brass ball, terminating in a male screw above, and in a female screw below. The ball has a vertical perforation, which commences with the lower screw, and terminates with the upper one. Another perforation, at right angles to this, causes a communication with the tube, which enters the ball at right angles. A similar, but smaller brass ball, may be observed above, with perforations similar to those in the larger ball, and a tube in like manner entering it laterally. This ball terminates in a male screw below, as well as above; and the thread of the lower male screw is curved to the left, while that of the larger ball, which enters the same nut (*n*) is curved as usual to the right: hence the same motion causes the male screws to approach, or recede from, each other, and thus determines the degree of compression given to a cork which is placed between them in the nut. At the top of the ball, a small screw may be observed, with a milled head. It is connected with a small tube which passes through a cork in the nut, and reaches nearly to the external orifice, from which the flame is represented as proceeding. This tube is, for the most part, of brass, but, at its lower end, terminates in a tube of platina. Into the female screw of the larger ball, a perforated cylinder of brass, (*c*) with a corres-

ponding male screw, is fitted. The perforation in this cylinder, forms a continuation of that in the ball, but narrows below, and ends in a small hollow cylinder of platina; which forms the external orifice of the blowpipe (*o*)

The screws (s s s s) are to keep, in the axis of the larger ball, the tube which passes through it, from the cavity of the smaller ball. The intermediate nut, by compressing, about the tube, the cork, which surrounds it, prevents any communication between the cavities in the two balls. By the screw (N) in the vertex, the orifice of the central tube may be adjusted to a proper distance from the external orifice. Three different cylinders, and as many central tubes, with platina orifices, of different calibres, were provided, so that the flame might be varied in size, agreeably to the object in view.

I have always deemed it best, to transmit the oxygen gas through the tube in the axis; since two volumes of the hydrogen, being required for one volume of oxygen, the larger tube ought to be used for the former: and the jet of hydrogen is placed between a jet of oxygen, within it, and the atmospheric air without.

Under the table, is a gallows, (G) with a screw for attaching a pipe, leading from a self-regulating reservoir of hydrogen.

Art. XIII.—*Description of a new species of Dory, called the crinited Zeus, from Block Island;* in a communication from Samuel L. Mitchill, LL. D. of New-York, to Aaron C. Willey, M. D. of New-Shoreham; dated March 17, 1826. (With a figure.)

My Dear Sir,

You are correct in the opinion, contained in your letter, that the uncommon fish drifted, some time since, to your shore, is a Dory, or Zeus. To me, as to yourself and your neighbours, it seems an individual of a species, not before observed. It does not belong to either of the three sorts, enumerated in my memoir, printed in the Transactions of the New-York Literary and Philosophical Society, Vol. II. It differs, in strong and striking points, from that sent me, not long ago, by Mr. Vernon, of Newport.

From the pretty appearance of your specimen, after having been rolled to land, by the waves, and subsequently dried, it must have been very showy and splendid, when alive.

The length is five inches and one half. The depth more than three inches and three quarters. The thickness, as in most of the dories, very inconsiderable. Colour of the back, bluish, or violet; of the belly, shining white; of the principal fins, yellowish, with variegations of black. Mouth of moderate size; and armed, in both jaws, with exceedingly fine and sharp teeth. Lower jaw projects somewhat beyond the upper. Tail deeply swallow-forked. Skin scaleless; or if there had been any, they had fallen off. Eyes large, with projecting brows. Gill-cover tripartite; the posterior margin of the foremost section, faintly jagged.

But the most singular part of its structure belongs to the dorsal and anal fins.

From a place a little behind the summit, or hump on its back, arises a fin, with seven rays. The hindermost of these is about half an inch long, and spinous. The second, rather more than two inches long, and bristly. The third, six inches long, and hairy. The fourth, fifth and sixth, of almost the same length. The seventh ray, counting from behind, forward, is of the extraordinary length of rather more than twelve inches; being bony about half way, and then gradually changing to hair, or a substance resembling the filament of whale-bone.

Also, from a space, a short distance behind the pelvis, arise five long rays. The hindermost of these, exceeds four inches in length; of the second, six inches; of the third, three; of the fourth, nine; of the fifth ray, counting toward the head, something more than six inches. Of these, the first, second and fourth, are capillary; the second, foliated at the extremity; and the fifth, setaceous.

The second dorsal fin is composed of eleven bifid flexible rays, connected by membranes.

The continuation of the anal fin, possesses, likewise, eleven two-cleft bristly rays, similarly united.

Ventrals very distinct in their origin, and widening in their progress. They are dark-coloured.

Pectoral fins have each seventeen rays, an inch, or rather more, in length, and acuminated, or somewhat falciform.

I have done all I could to preserve so interesting an article for my museum, and for the inspection of those who may wish to see it.

Now, after such a description, it becomes me further to tell you, what I think of this rare production. I repeat my belief, that it is a non-descript. I am the more inclined to think so, since the *Zeus ciliaris* of BLOCH, which is known by some ichthyologists, as the "long-haired Gal," is noted as having been received by him, from Dr. Kœnig, of Surat; and as being an inhabitant of the East-Indian Seas. The present seems to be known only in the North Atlantic Ocean, and differs, in various characteristic points, from the preceding.

I should, probably, have been less attentive to the subject, had not my curiosity been roused by a paper recently received from Paris. It is the memoir on certain fishes of the sea, and their geographical distribution, by Messrs. QUOY and GAIMARD, naturalists, on the voyage of discovery around the globe, with Captain Freycennet. It was read before the Society for the Promotion of Natural History, and printed in the Annals of Natural Science, conducted by Messrs. Audouin, Brongniart and Dumas. The writers have presented interesting observations, concerning the scaly and finny tribes; among which are those on the uninhabited desarts and solitudes of the water, resembling the lonesome and unfrequented wastes and barrens, on the land.

For the present, I am disposed to distinguish the species by the name of *Zeus crinitus*, or the Crinited Dory; and to make its specific character consist in having "seven rays to the first dorsal fin, six of which are long; and five long rays to the forepart of the anal fin."

Leaving, after all, to our successors, the task of examining more and fresh specimens, and of making therefrom a full and final decision, I present you, without delay, my cordial salutation and thanks.

SAMUEL L. MITCHILL.

Art. XIV.—*Caricography.* By Prof. Dewey.

(Continued from Vol. X. p. 284.)

[Communicated to the Lyceum of Natural History of the Berkshire Medical Institution.]

85. Carex *digitalis*, Willd.
Muh. no. 47.
Pursh, Eaton, Schw. and Torrey, no. 49.
Ell. no. 43. Pers. no. 168.

Spicis distinctis; spica staminifera solitaria; spicis fructiferis ternis tristigmaticis alternis laxifloris cum pedunculis longis filiformibus cernuis; fructibus ellipticis triquetris obtusis nervosis glabris, squama ovata acuta longioribus.

Culm short, erect, triquetrous; leaves of the culm sheathing,—radical leaves lanceolate, rather broad, glaucous, and nerved; staminate spike single and terminal, with an obtuse, lanceolate scale, tawny on the margin; pistillate spikes two or three, distant, alternate, on long, slender, nodding peduncles; stigmas three; fruit elliptic, *obtuse*, triquetrous, nerved, glabrous, distant, with a scale ovate and acute, or oblong-lanceolate, carinate, shorter than the fruit.

Flowers in May—grows in marshes. Penn.—Muh.

The description of this species is derived from Willd., Muh., and Schk., as I suppose the plant has never come under my observation. The species, no. 49, described by Schw. and Torrey, and supposed to be the C. *digitalis*, Willd. (for the Herbarium of Muh. seems not to contain the plant), is acknowledged to be the C. *gracillima*, Schw. described in this Journal, Vol. VIII. p. 98. and their description does not at all agree with that of Muh. or Willd. Until the two plants are proved to be identical, by an actual comparison of specimens, the following characters will be judged sufficient for considering them different species. The name of C. *digitalis* implies that it is *short*, and Willd. states it to be "in altitudine digitalis," a *finger* in height, or about four inches; C. *gracillima* is from one to two feet in height, and often is more than three feet in height:—the former has radical *glaucous* leaves; the latter has not, and the colour of its leaves is light or yellowish green:—the fruit of the former is

elliptic, *ventricose*, *triquetrous*, and *most obtuse*, (Willd.) and its scale oblong-lanceolate, or ovate-acute ; the fruit of the latter is oblong, triquetrous, obtuse, oblique at the orifice, with an oblong, obtuse, awned scale ; the former grows in *marshes ;* the latter in moist meadows or pastures, or along hedges, but never in our marshes. C. *digitalis* is *related* (Muh.) to C. *oligocarpa*, and its leaves are rather broad ; C. *gracillima* has no marked affinity to C. *oligocarpa*, and its leaves are not broad in respect of the height of the plant or of those of the species generally. The highest spike of C. gracillima is generally androgynous, having nearly the higher half of it pistillate,—a character not alluded to by either Willd. or Muh. If the two plants belong to one species, it must be acknowledged to be very variable. C. *digitalis* is nearly related, according to the description, to C. *pyriformis*, Schw., the C. *aurea*, Nutt. The chief difference, indeed, is, that the former has three stigmas, the latter two ; that the fruit of the former is triquetrous, of the latter is not in a fresh state, though it is often triquetrous, when quite mature.

86. C. *dasycarpa*. Muh.
Muh. no. 26.
Ell. no. 27. tab. 12, fig. 4.
Mon. no. 63.

Spicis distinctis ; spica staminifera subsessili parva ; spicis fructiferis tristigmaticis subternis subapproximatis oblongis alternis, inferioribus subpedunculatis ; fructibus ovato-triquetris vel oblongis *villosis* nervosis, squama ovata acuminata longioribus.

Culm a foot or more in height, glabrous, triquetrous ; leaves linear-lanceolate, glabrous, narrow, shorter than the culm ; bracts linear, surpassing the culm, with very short sheaths ; staminate spike single, nearly sessile, small, with a lanceolate, obtuse scale, white, but green on the keel ; pistillate spikes two or three, approximate, upper one sessile, lower on short peduncles ; stigmas three ; fruit ovate or oblong, obtuse, triquetrous, entire at the orifice, very villose ; pistillate scale ovate, acuminate, shorter than the fruit.

Flowers in May—found on Paris' Island, South-Carolina. Spikes and fruit larger than those of C. *virescens*.—Elliott. Also, in Salem, N. C.—Schw.

According to Schw. and Torrey, the plant in the Herbarium of Muh. is the C. *dasycarpa* figured by Elliott.

87. C. *capillaris.* Lin.
Pers. no. 173. Wahl. no. 91.
Rees' Cyc. no. 152.
Schk. tab. O. fig. 56.
Schw. and Torrey, no. 85.

Spica staminifera solitaria pedunculata parva; spicis fructiferis tristigmaticis subternis longo-exserté pedunculatis cernuis oblongis sparsifloris, subpaucifloris; fructibus ellipticis rostratis utrinque acuminatis ore obliquis, squama ovata vel oblonga obtusa decidua vix duplo longioribus.

Culm one to eight inches high, slender, capillary, leafy towards the base; leaves linear-lanceolate, often long as the culm; pistillate spikes two or three, oblong, loose flowered, on very slender, long, and recurved peduncles often surpassing the staminate spike and sheathed; stigmas three; fruit elliptic, rostrate, attenuated at either extremity, glabrous, dark brown in maturity, with an oblique orifice and the beak often somewhat excurved; pistillate scale ovate, or oblong, sometimes rather obovate, obtuse, white on the edge and membranous, more than half as long as the fruit.

This species, common in Europe, was found by Dr. Richardson, in the woods of Arctic America. I have only European specimens of this plant. As it inhabits alpine districts, it may, perhaps, be found on the mountains of the northern States.

88. C. *ustulata.* Wahl.
Pers. no. 178. Wahl. no. 92.
Rees' Cyc. no. 127.
Schw. and Torrey, no. 84.
C. *atrofusca*, Schk. tab. Y. fig. 82.

Spica staminifera oblonga recurvata solitaria; spicis fructiferis tristigmaticis binis ovalibus exserte pedunculatis nutantibus; fructibus ovatis rostratis acuminatis utrinque planiusculis atris ore bidentatis, squama ovata subduplo longioribus.

This beautiful species, found on the Alps, has been found also in Labrador, whence it was sent to Mr. Schweinitz. On the European plant, the upper pistillate spike is near the staminate,—the other about an inch below and larger; scales alike on all the spikes, very dark coloured like the fruit;

leaves short and subradical; bracts loosely sheathing and scarcely forming a leaf; the angles of the fruit rather acute and scabrous above the middle. This species may perhaps inhabit the mountainous parts of the northern States. The characters clearly distinguish this plant from C. *atrata*.

89. C. *filifolia*. Nuttall.
Nutt. Gen. II. p: 204.
Schw. and Torrey, no. 9.

Spica unica androgyna superne staminifera subcylindracea acuta; fructibus subglobosis ore integris cum squama retusa; foliis filiformibus involutis subulatis.

Cespitose, scarcely a hand breadth high, (Nutt.); leaves radical, surpassing the culm, filiform, spreading; fruit six to eight at the base of the spike, lax, somewhat pubescent, with an oblique orifice, (Schw. and Torrey.)

Common on dry plains and gravelly hills of the Missouri —Nutt. Also in Arctic America—Dr. Richardson.

90. C. *glaucescens*. Elliott.
Ell. Sketch II. p. 553. Mon. no. 94.
C. *sempervirens*. Schw. An. Tab.

Spica staminifera solitaria cylindracea pedunculata; spicis fructiferis tristigmaticis subternis pedunculatis cylindraceis demum pendulis; fructibus ovatis triquetris compressis *glaucis* subrostrato-bifidis, squamæ ovatæ peremarginatæ mucronatæ subæqualibus.

Culm about two feet high, glabrous, slightly scabrous above, triquetrous; leaves narrow, scabrous on the edge, shorter than the culm, lower ones glaucous; staminate spike single, cylindric, long pedunculate, with ovate, emarginate and mucronate scales tawny with a green keel; pistillate spikes three or four, cylindric, with long and slender sheathless peduncles recurved in maturity; stigmas three; fruit ovate, compressed, triquetrous, very glaucous, with a very short two cleft orifice; pistillate scale ovate, deeply emarginate, mucronate, shorter than the fruit, but its mucronate point extending beyond the fruit.

Flowers in April and May—grows about ponds in pine barrens—Elliott. Also, near Augusta, Geo.

This species is adopted from Mr. Elliott's Sketch: it appears to be very distinct. On my specimens the leaves are

rather longer than the culm. The deeply emarginate and mucronate scale is very peculiar.

91. C. *Elliottii.* Torrey.
Schw. and Torrey, no. 95.
C. *fulva?* Muh. no. 37.
C. *castanea*, Ell. no. 35.

Spica staminifera solitaria perlongo-bracteata; spicis fructiferis tristigmaticis ternis subrotundis, superioribus sessilibus et suprema apice staminifera, infima longissime pedunculata cernua; fructibus ovatis subtriquetris glabris puncticulosis nervosis longo-rostratis bifurcatis, squama ovata obtusa multo longioribus.

Stoloniferous; culm two feet high, triquetrous, very slender, purple at the base; leaves linear, nerved, somewhat rough on the edge, shorter than the culm; staminate spike single, an inch long, rising from a leafy bract three-nerved and much longer, with an oblong and obtuse scale tawny, and white on the margin; pistillate spikes three, alternate, roundish, 9—16 flowered, the highest two sessile and the upper one staminate above, the lowest on a very long nodding peduncle; stigmas three; fruit ovate, inflated, subtriquetrous, nerved, glabrous, dotted, coriaceous, long rostrate and two cleft, becoming yellow; pistillate scale ovate, obtuse, not half as long as the fruit.

Flowers in April—grows in wet pine barrens, Chatham, Co. Georgia—Elliott. On my specimens the long pedunculate spike is wanting—bracts very long and narrow.

Muhlenberg doubted the identity of this plant with the C. *fulva* of Europe; and so remote is it from C. *fulva* as figured in the Lin. Trans. that Mr. Elliott has given it another name. The strong affinity of the plant to C. *folliculata* and its general characters show it to be very different from specimens of C. *fulva*, as well as from the figure of C. fulva, Gooden. in Schk. tab. T. fig. 67. But as Wahlenberg had long before appropriated C. *castanea* to a very different species, I had, for an obvious reason, given it the name above, before it was announced in the Monograph by Schw. and Torrey. This plant seems nearly related also, to C. *oligosperma*, Mx.

92. C. *Richardsonii*. R. Brown.
Schw. and Torrey, no. 60.

Spica staminifera solitaria pedunculata erecta; spicis fructiferis tristigmaticis binis subsessilibus approximatis incluse pedunculatis; fructibus ovatis obtusis pubescentibus cum squama ovata acuta; culmo scaberrimo.

Culm half a foot high, deeply channelled and very scabrous towards the base, with purplish brown sheaths above the middle, terminating in very short leaves, and with a dense tuft of rigid, smooth leaves, about the root; staminate spike single, pedunculate, with ovate rather obtuse scales brown with a white border; pistillate spikes two, on short peduncles, inclosed in the sheaths of large oblong bracts; stigmas three; fruit ovate, pubescent, with ovate and acute scales of a brown colour. *Mon.*

Found in Arctic America, by Dr. Richardson. See Appendix to Frank. Nar. 2nd. ed.

93. C. *concinna*. R. Brown.
Schw. and Torrey, no. 61.

Spica staminifera sessili cylindracea oblonga; spicis fructiferis tristigmaticis ternis subsessilibus approximatis; fructibus triquetro-obovatis brevissime rostratis bidentatis hispido-pubescentibus, squama obovata subduplo longioribus.

Culm four inches high, filiform, triquetrous, smooth; leaves subradical, rigid, smooth, spreading; staminate spike oblong, very nearly sessile, with broad ovate obtuse scales; pistillate spikes three, subsessile, 3-4 flowered, near; stigmas three; fruit obovate and subtriquetrous, bidentate, hispidly pubescent with obovate or roundish ovate scales obtuse and about half as long as the fruit. *Mon.*

Found in Arctic America, by Dr. Richardson. See Appendix to Frank. Nar. ed. 2.

94. C. *fuliginosa*. Schk.
Schk. tab. Cc. fig. 47, *c.*
Schw. and Torrey, no. 50.
C. *frigida*, Allion. secund. Wahl. no. 83.
——— β. *fuliginosa*. Pers. no. 158.

Spicis oblongis subquaternis tristigmaticis, terminali androgyna inferne staminifera, inferioribus exserte pedunculatis cernuis; fructibus oblongis mucronatis apice bifidis squama oblonga longioribus.

This species is considered by Wahl. and Pers. as only a variety of C. *frigida*, Allion., the C. *spadicea*, Schk. tab. L. fig. 47 *a.* and *b.* The difference in the situation of the staminate flowers and in the shape of the fruit seems to justify Schk. in making it a distinct species. It seems not to be very common in Europe—growing on the Alps. Found in Arctic America by Dr. Richardson.

95. C. *misandra.* R. Brown.
Schw. and Torrey no. 51.

Spicis subternis tristigmaticis ovalibus pedunculatis pendulis alternis vel raro subumbellatis, terminali androgyna inferne vel rarius omnino staminifera; fructibus lanceolatis acuminatis bidentatis apice denticulatis, squama ovali obtusiuscula longioribus.

Culm about half a foot high; leaves linear, attenuated above, scabrous on the margin; spikes three or four, oval or oblong, pendulous, the highest generally pistillate above; stigmas three, sometimes two; fruit lanceolate, bidentate, nearly black, white at the orifice, smooth except the higher part of the margin, longer than the oval and rather obtuse scale smooth and dark brown. *Mon.*

Found on Melville Island—R. Brown. See App. Parry's 1st Voyage.

96. C. *viridula.* Mx.
Mx. Fl. II. p. 170.
Schw. and Torrey no. 45.
C. *triceps*, Ell. no. 22.

Spicis tristigmaticis subternis approximatis ellipticis sessilibus, terminali androgyna inferne staminifera, inferioribus axillaribus; fructibus ovatis triquetris glabris acuminatis, squamam ovato-acuminatam subæquantibus.

Culm about a foot high, erect, slender, triquetrous, scabrous above, purplish below; leaves linear, erect, slightly scabrous on the edge, little longer than the culm, pubescent below; spikes three or four, approximate, sessile,—terminal one staminate below, a little remote; stigmas three; fruit ovate, a little compressed, prominently nerved, subtriquetrous, pubescent when young ?—pistillate scale ovate and acuminate, about as long as or a little longer than the mature fruit.

Flowers in April and May, in damp soils, in South-Carolina—Elliott; in pine forests, North-Carolina—Schw. and Torrey; in Canada—Mx.

This species is allied to C. *virescens*, (Elliott), and between that and C. *hirsuta*, (Schw. and Torrey). A plant, which answers generally to this description, I have found in this town, in gravelly soil along a hedge—but have considered it only a variety of C. *hirsuta*, as its fruit is pubescent when young. There is scarcely a doubt that the C. *triceps*, described by Mr. Elliott, and the C. *viridula* in the *Mon.* are one species. But the C. *triceps*, Mx. seems very certainly to be C. *scirpoides*, Schk. Though I have followed the *Mon.* in naming this species C. *viridula*, Mx. as I am not confident it is found here, yet there is much reason for suspecting that the true C. *viridula*, Mx. is a very different plant, since Michaux states its affinity to C. *triceps* and C. *flava*!!

97. C. *Wormskioldiana.* Hornemann.
Schw. and Torrey no. 3.
C. *scirpoidea*, Mx. Pursh. no. 1.
C. *Michauxii*, Schw. An. Tab.

Dioica planifolia distigmatica ?—spica oblonga unica imbricato-cylindracea acuta; fructibus ovalibus subrostratis dense pubescentibus; squamis acutis.

Culm 3—6 inches high, nearly round, smooth, sheathed at the base; leaves flat, smooth, about the length of the culm; spike cylindric, imbricate, oblong, acute; fruit densely pubescent, somewhat rostrate, oval, with acute and dark brown scales. *Mon.*

Found at Hudson's Bay—Mx. Also in the woods of Arctic America—Dr. Richardson. See App. Frank. Nar. ed. 2.

From the description it is obvious that this plant is closely related to C. *dioica*, and intermediate between that and its variety, C. *Davalliana*, Wahl. It is, perhaps, only another variety.

98. C. *Fraseri*. Sims.
Pursh no. 27. Schw. and Torrey no. 4.
C. *Lagopus*, Muh. no. 59.

Spica unica androgyna superne staminifera cylindracea, fructibus tristrigmaticis subtriquetris ovato-globosis ore integris striatis, squama oblonga longioribus.

This peculiar species I have not had opportunity to examine. According to Muhlenberg, the culm is a foot high, naked, sheathed at the base, compressed above, with two radical and broad-lanceolate leaves nerved, and longer than the culm; spike single cylindric, white, staminate above; stigmas three; fruit glabrous, striate, and subtriquetrous. Leaves *ever green*.

Found on the mountains of N. Carolina—Fraser. Also, in Penn.—Muh.

Note. Four species, some of whose peculiarities only were given in Vol. VII. will here be fully described.

C. *plantaginea*. Lam.
Pursh, Mx. Eaton, Pers. no. 143. Rees' Cyc. no. 135.
Ell. no. 34. Schw. and Torrey no. 76.
C. *latifolia*, Goert. secund. Wahl. no. 94.
——————Schk. tab. U. fig. 70. Rees' Cyc. no. 128.

Spica staminifera solitaria erecta pedunculata; spicis fructiferis tristigmaticis subquaternis oblongis subsparsifloris erectis remotis exserte pedunculatis fructibus oblongis triquetro-ellipticis subcuneiformibus utrinque attenuatis apice excurvis ore integris, squama ovato-cuspidata longioribus; foliis latissimis ensiformibus.

Culm 10—20 inches high, erect, triquetrous, smooth, with dark reddish brown sheaths towards the base; sheaths of the peduncles coloured in part, terminating in a short dark brown subulate point or leafet; leaves radical, linear, rather obtuse, green through winter, shorter than the culm, often an inch in breadth, flat, commonly with three *strong nerves* or *ribs* purplish at the base; staminate spike single, erect, pedunculate, oblong-cylindric, with dark reddish brown scales oblong and rather acute and narrowed towards the base with a whitish midrib; pistillate spikes three to five, erect, oblong, loose flowered, the two upper with nearly inclosed peduncles and the lower with rather long exsert peduncles, remote, the lowest from towards the root; stigmas three; fruit oblong, triquetrous, attenuated at both ends, appearing pedicillate, sub-

rostrate and excurved at the apex, entire at the orifice; pistillate scale ovate, cuspidate, varying from half to the whole length of the fruit. Colour of the plant bright and deep green.

Flowers in April and May—common in this part of the country in rather dry and open woods and along upland hedges. Alleghany Mts.—Schw.—also in Virginia.

This is a very distinct and beautiful species, and to those who are familiar with both, there seems no reason for confounding it with C. *anceps*. This has been often done, and the fig. tab. Kkkk 195 is referred by Schk. to this species, while it belongs unquestionably to C. *anceps*. In the *Mon.* there is no reference to Schk. tab. U. fig. 70, although there can be no doubt that the fig. was drawn from a *true*, though imperfect specimen of C. *plantaginea*. The plant was cultivated at Paris from seed supposed to be obtained from S. America, and was in the Herbarium of Thunberg, obtained from Virginia, as we learn from Wahlenberg. The reference in Rees' Cyc. of C. *latifolia*, Wahl. to the fig. in tab. M. of Schk. is evidently a mistake,—as Wahl. refers his plant to tab. U. fig. 70 Schk. Whether Willdenow possessed the plant may be doubtful; yet he had other sources for obtaining it than the hand of Muhlenberg, liberal as that seems to have been in sending him the Carices of our country.

C. *granularis*. Muh.
Muh., Pursh, Eaton, Pers. no. 149.
Ell. no. 38. Schw. and Torrey no. 83.
Schk. tab. Vvv. fig. 169.

Spica staminifera solitaria erecta sub-pedunculata; spicis fructiferis tristigmaticis subternis cylindraceis densifloris, superioribus subsessilibus saepe approximatis, inferioribus sublongo-exserte pedunculatis; fructibus subrotundo-ovatis, apice recurvis brevissime rostratisque integris nervosis, squama ovata acuminata vix duplo longioribus.

Culm 8—16 inches high, erect or subdecumbent, triquetrous, smooth; leaves linear-lanceolate, nerved, glaucous, long as the culm, shorter below, rather soft, slightly scabrous on the edge; bracts long, leafy, much surpassing the culm, with whitish sheaths; staminate spike single, often short, erect, triquetrous, usually short pedunculate, very rarely pistillate above or at all, with a lanceolate scale whitish yellow and green on the keel; pistillate spikes three or four, ob-

long, cylindric, densely flowered, two highest often near and nearly sessile, two lower remote and the lowest especially on a long exsert peduncle; stigmas three; fruit roundish-ovate, nerved, very short beaked and recurved, entire at the orifice, becoming of a dull heavy yellow colour in maturity; pistillate scale ovate, acuminate, white on the edge, rather more than half the length of the fruit. Colour of the plant rather glaucous green—in maturity yellowish.

Flowers in May—grows in wet upland meadows and pastures—common.

This is a very distinct species—its culm resembles some varieties of C. *anceps* and also C. *blanda*; but its spikes and fruit are quite different. The fruit is more like that of C. *blanda*, and the latter may sometimes be confounded with it without special attention. It is closely related to the European species, C. *rotundata*, Wahl. the C. *globularis*, Schk. tab. Gg. fig. 93—from which however it is clearly distinct.

C. *straminea*. Wahl.
Muh. Pursh, Eaton, Pers. no. 73.
Schw. and Torrey no 34.
Schk. tab. Xxx. fig. 147.

Spica composita; spiculis androgynis inferne staminifera distigmaticis subsenis ovatis oblongis alternis sessilibus subapproximatis; fructibus lato-ovatis sub-rotundis compressis *alatis* ciliato-serratis rostratis nervosis bidentatis, squama ovato-lanceolata paulo longioribus.

Culm 8—20 inches high, triquetrous, scabrous above; leaves linear-lanceolate, shorter below and shorter than the culm, with striate sheaths tawny opposite the leaf; spikelets 3—8, usually five or six, ovate, oblong, roundish in maturity, approximate especially at the summit, staminate below, sessile, very rarely subpedunculate, with ovate cuspidate bracts; staminate scale lanceolate, somewhat tawny; fruit, broad-ovate, roundish, rostrate, nerved, *winged* on each side and of the breadth of the seed, two-toothed, ciliate-serrate, quite compressed; pistillate scale ovate-lanceolate, varying from about half to nearly the length of the fruit. Colour of the spikes tawny,—of the plant light green.

Flowers in May—grows in fields along the borders of moist woods—sometimes on ledges of rocks, and its fruit is less broad and its scale longer—common, but not abundant.

Schk. has given an excellent fig. of this species. The plant resembles C. *scoparia* in the colour of its spikes, but its fruit is very different. It is oftener confounded with C. *festucacea*, from which however its characters clearly separate it.

The C. *albolutescens* Schw. An. Tab. seems to be only a variety of the common C. *straminea*. On the specimens from Penn. and Ohio, is to be seen the characteristic *broad winged* fruit.

β. *brevior*. (Mihi.) C. *straminea*, Wahl. no. 38.
Schk. tab. G. fig. 34. Rees' Cyc. no. 50.

Spicis subquinis saepe approximatis sessilibus; fructibus brevi-ovatis et brevi-rostratis, squama lanceolata vix longioribus.

This variety differs in the shorter ovate fruit, with a very short beak, and hence more nearly round, compressed like the other. The spikelets are also smaller, more distinctly ovate. Grows with the other—also in Missouri. It was this variety which was described by Willd, and to which the name was given. Muh. as well as Schk. refer both the figs. in Schk., with propriety, to the same species.

C. *trichocarpa*. Muh.
Muh., Pursh, Eaton, Pers. no. 188.
Ell. no. 25. Schw. and Torrey no. 101.
Schk. tab. Nnn fig. 148.

Spicis staminiferis subternis erectis, inferioribus sessilibus, raro androgynis; spicis fructiferis ternis tristigmaticis erectis longo-cylindraceis gracilibus subremotis sublaxifloris exserte pedunculatis, infima subincluse pedunculatis; fructibus ovato-lanceolatis subconicis inflatis nervosis rostratis bifurcatis dense pubescentibus, squama ovato-lanceolata subduplo longioribus.

Culm 18—30 inches high, triquetrous, scabrous above; leaves linear-lanceolate, rough on the edge, as long as or longer than the culm, striate, with striate sheaths purple and concave opposite the leaf; bracts long and leafy; staminate spikes two to five, erect cylindric, highest pedunculate, often pistillate at the apex (Muh.) with an oblong and obtuse scale tawny, white on the margin; pistillate spikes three, erect, long cylindric, often two inches long, slender, rather loose flowered,—upper ones exsertly pedunculate with short

sheaths, and the lowest peduncle nearly inclosed in a longer sheath ; stigmas three, sometimes two (Muh.) fruit ovate-lanceolate, round and conic, inflated, rostrate, nerved, bifurcate, with a dense brownish pubescence in maturity ; pistillate scale ovate-lanceolate, tawny on the edge, distinctly nerved, little more than half as long as the fruit. Colour of the plant light green.

Flowers in May—grows in marshes—common in N. England and N. York. Penn.—Muh. ; S. Carolina—Ell.

Though Muh. found the staminate spikes often pistillate at the apex, and the plant is thus figured by Schk., later botanists have rarely found them thus, and the plant should be removed to the last subdivision of the species of this genus in Pursh, Eaton, and Nuttall's Gen.

β. *turbinata*, Dewey. tab. fig. vol. XI.

Spicis fructiferis ternis tristigmaticis ovatis et ovato-oblongis crassis remotis densifloris, superioribus subexserte pedunculatis, inferioribus longo-exserte pedunculatis ; fructibus ovato-lanceolatis conicis inflatis rostratis nervosis bifurcatis subdivergentibus pubescentibus, squama ovato-oblonga submucronata paulo longioribus.

Culm, leaves, bracts, and sheathes like the preceding—as also the staminate spikes, but the staminate scale, is oblong, mucronate and tawny; pistillate spikes three, sometimes four, upper ones nearly sessile or with inclosed peduncles,—lowest often with a long peduncle projecting far from the sheath,—ovate, and ovate-cylindric, about an inch long, generally thick, rather densely flowered ; stigmas three ; fruit like the preceding, but rather diverging ; pistillate scale ovate-oblong, submucronate, with a scabrous point, tawny on the edge, three-nerved, green on the keel, about two thirds as long as the fruit. Colour of the plant glaucous green.

Flowers in May—grows along a pond near the village in Beekman, Dutchess co. N. Y.

This plant bears so strong a resemblance to the common C. *trichocarpa*, though it differs especially in its pistillate spikes, that I have judged it to be only a variety.

99. C. *verrucosa*. Muh.

Muh. no. 50. Ell. no. 49. Mon. no. 102.

Spicis staminiferis pluribus vel unica ; spicis fructiferis tristigmaticis subquinis erectis cylindraceis superne staminiferis axillaribus, infima exserte pedunculata ; fructibus ovatis com-

pressis subtriquetris brevi-bifidis, squama ovata subemarginata mucronata brevioribus.

Culm 2—3 feet high, triquetrous, striate, purple below, scabrous above, glabrous; leaves linear-lanceolate, very long, somewhat glaucous, scabrous on the margin, nerved, dotted, sheathing towards the base; bracts long, leafy, with sheaths inclosing the upper peduncles; staminate spike single (Muh.,) three (Ell.,) cylindric, terminal one long, pedunculate, obtuse, with one oblong scale mucronate and brown; pistillate spikes four to six, two or three inches long, cylindric, erect, staminate at the summit, inclosed-pedunculate except the lowest, whose peduncle is sheathed at the base; stigmas three; fruit ovate, indistinctly nerved, compressed, somewhat triquetrous, short-cleft orifice, glaucous; pistillate scale ovate, obtuse, sometimes distinctly emarginate, mucronate, brown, a little longer than the fruit.

Flowers in May—found in Carolina and Georgia—Muh. and Ell. N. Carolina—Schw. Muh. remarked the resemblance between this plant and C. *flacca*, Schreb., the C. *recurva*, Gooden.—but the two seem to be clearly distinct.

100. C. *oligosperma*. Mx.
Mich. Fl. vol. II. p. 174.

Spicis staminiferis pluribus; spica fructifera tristigmatica unica globulari sessili; fructibus turgide ovatis majusculis paucissimis acutis; foliis involuto-junceis.

Found in Canada by Michaux, to whom the world is indebted for all its knowledge of the plant. Culm and leaves erect; bract supporting the pistillate spike setaceous, as long as, or longer than, than the staminate spike. The description corresponds to no other known species, and the plant will doubtless be found again in Canada, and perhaps in the northern part of the U. States. It is related to C. *Elliottii*, but differs in the number of staminate spikes, and in the form of its fruit.

101. C. *Cherokeensis*, Schw.
Schw. An. Tab. Schw. and Tor. no. 112. pl. 25. fig. 1.
C. *recurva* ? Muh. no. 55.

Spicis stameniferis subternis subcylindra ceis, suprema majore et fredunculata; spicis fructiferis tristigmaticis quaternis cylindraceis subloxifloris distantibus exserte et sublongo-pedunculatis superne stameniferis; fructibus ovatis glabris sub-

triquetris subcompressis nervosis longo-rostratis bifidis, squama ovata longo-acuminata paulo majoribus.

Culm a foot high, triquetrous, glabrous, striate; leaves linear-lanceolate, rough on the edge, nerved, shorter than the culm, glaucous, with striate sheaths; bracts leafy, sheathing; staminate spikes two to four, somewhat cylindric, approximate, whitish, lower ones sessile and shorter, with an oblong scale obtuse and white; pistillate spikes about four, sometimes two to five, alternate, cylindric, loose-flowered, with peduncles projecting considerably from the sheaths; stigmas three; fruit ovate, nerved, white, glabrous, bifid, long-rostrate, somewhat compressed; pistillate scale ovate, long acuminate, white with a green keel, a little shorter than the fruit. Colour of the plant glaucous green.

Found in the Cherokee country—Muh. and Schw. Also at St. Louis, Missouri —Dr. L. C. Beck.

There can be no doubt that this is the species no. *55* of Muh., or that it is not C. *recurvá*, Gooden., the C. *flacca*, Schk. It appears to be a beautiful and distinct species. On the plant from Missouri, there are only two pistillate spikes—pistillate scale longer than the fruit before maturity. I had referred it to no. *55* Muh.—but it is evidently the same also as C. *Cherokeensis*.

102. C. *aristatá*. R. Brown.
Schw. and Torrey no. 104.

Spicis staminiferis binis vel pluribus; spicis fructiferis tristigmaticis subternis cylindraceis distantibus brevi-pedunculatis; fructibus glaberrimis nervosis longissime rostratis alto bifidis; squamis aristatis; foliis subtus et vaginis villosis.

Found by Dr. Richardson in Arctic America, and said to be between C. *bullata* and C. *lacustris*, Mon. See App. Frank. Nar. ed. 2.

This plant is entirely different from C. *Torreyana*, described in this Journal Vol. X. p. 47,—the name having been changed to this on account of the previous application of the former name to the species described above. *After the publication* of C. *Torreyana*, the same plant was published under the name of C. *Davisii* in the Mon. The latter name must therefore be given up.

103. C. *Barrattii*. Torrey.
Schw. and Torrey no. 100.
C. *littoralis*, Schw. An. tab.

Spicis staminiferis subbinis; spicis fructiferis tristigmaticis subternis oblongo-cylindraceis cernuis distantibus superne staminiferis; fructibus oblongis subtriquetris brevi-rostratis subscabris ore integris, squama ovato-lanceolata subobtusa paulo brevioribus.

Culm a foot high, triquetrous, rather rigid; leaves erect, very glaucous and smooth, shorter than the culm; staminate spikes two, upper one oblong, with ovate scales obtuse and dark brown; pistillate spikes about three, oblong-cylindric, an inch or more in length, rather loose flowered, the two lowest on long peduncles projecting from sheaths; stigmas three; fruit oblong, somewhat triquetrous, short rostrate, nearly entire at the orifice; pistillate scale ovate-lanceolate, rather obtuse, dark brown, a little longer than the fruit. Mon.

Found on the coast of New-Jersey near Cape May.—Schw. and Torrey.

104. C. *podocarpa*. R. Brown.
Schw. and Torrey no. 88.

Spica staminifera solitaria; spicis fructiferis tristigmaticis binis oblongis pendulis; fructibus ellipticis brevissime rostratis integris laevibus; *semine pedicillato;* foliis inferioribus abbreviatis.

Found in Arctic America by Dr. Richardson. Mon. See App. Frank. Nar. ed. 2.

105. C. *varia*. Muh.
Muh., Pursh, Eaton, Pers. no 98.
Ell. no 26. Schw. and Torrey no. 59.
Schk. tab. Uuu fig. 167.

Spica staminifera solitaria erecta brevi vel elongata; spicis fructiferis tristigmaticis ternis ovatis sessilibus subapproximatis paucifloris; fructibus ovali-ventricosis vel subtriquetro-globosis acuminato-rostratis bifidis scabro-pubescentibus, squamæ ovatæ acuminatæ subæqualibus.

Culm 4—12 inches high, triquetrous, scabrous above, erect, slender, purple towards the base; leaves subradical, linear, narrow, rough on the edge, often equalling the culm; bract ovate, lanceolate, short, supporting the pistillate spikes; sta-

minate spike single, erect, pedunculate, often very nearly sessile, sometimes an inch long, often not half an inch long, with ovate scales acuminate, brown or purplish, white on the margin; pistillate spikes two or three, very rarely four, ovate or globose, sessile, erect, about six-flowered, bracteate; stigmas three; fruit oval-ventricose, nearly globose, somewhat triquetrous from three nerves or ribs, acuminated into a beak, bifid, rough-pubescent; pistillate scale ovate, acuminate, tawny, often green, whitish on the margin and keel, about the length of the fruit, lower ones sometimes slightly mucronate.

Flowers in April and May—grows in dry woods and along hedges in vallies and hills—common over the country.

β. *pedicellata.* (Mihi)
C. *varia,* Wahl. no. 107. Rees' Cyc. no. 85.

Spicis fructiferis ovato-oblongis brevi-pedunculatis erectis; bractea inferiore foliacea.

Pistillate spikes ovate-oblong, loose-flowered, short but distinctly pedunculate, about six to eight-flowered; bract under the lowest spike lanceolate, long, leafy, often nearly equalling the culm.

This variety bears considerable resemblance to C. *longifolia,* Host. Grows with the other—very common.

The striking resemblance between C. *varia* and C. *pilulifera,* L. Schk. tab. I fig. 39, has often been noticed; but on comparing specimens of the latter with the former, they appear to possess very distinct characters.

Our plant, as its name implies, is a variable species. Its varieties differ much in height, size, situation and length of the spikes, rigidity or laxness and length of the leaves. Generally, it is readily recognized. This species greatly resembles the following.

106. C. *marginata.* Muh.
Muh. Pursh, Eaton, Pers. no. 101. Ell. no. 28.
Schw. and Torrey no. 64.
Schk. tab. Lll fig. 143.
C. *Pennsylvanica,* Lam. Rees' Cyc. no. 83.

Spica staminifera solitaria erecta pedunculata subtriquetra; spicis fructiferis tristigmaticis binis ovatis subssessilibus subapproximatis paucifloris; fructibus ovato-globosis brevi-ros-

tratis subbidentatis tomentosis, squamæ ovatæ acuminatæ vel oblongæ mucronatæ subæqualibus.

Culm 4—16 inches high, triquetrous, scabrous above; leaves linear, scabrous on the edge, the culm leaves short, those of the previous year often longer than the culm, with purplish sheaths at the base; a linear bract under and longer than the lowest spikelet; staminate spike subtriquetrous, with an ovate or oblong scale obtuse or acute, bright brownish red, white on the edge and keel; pistillate spikes one to three, commonly two, ovate, sometimes rather oblong, sessile or slightly pedunculate, four to eight-flowered, often only one spike with sometimes the rudiment of another; stigmas three; fruit ovate-globose, short rostrate, slightly bidentate, scarcely triquetrous, tomentose; pistillate scale ovate, acuminate, or oblong mucronate, little longer or shorter than the fruit, reddish brown, white on the margin.

Flowers in April and May—grows in the same situations as the preceding—common.

This plant, when it has only one pistillate spike, resembles C. *montana*, L. Schk. tab. F fig. 29, whose fruit is rather acute at both ends. It is more closely allied to C. *varia*. To those acquainted with the figures of the two species in Schk. they are readily known. Their general appearance is different—although the characters are so similar. C. *marginata* has a larger staminate spike, with more deeply coloured scales; its culm is larger and more rigid; its fruit more round with a shorter beak and less distinctly bidentate. As it occurs in woods, with only one pistillate spike, or with the rudiment of another, it is unquestionably the C. *Pennsylvanica*, Lam. according to the description in Rees' Cyclop.

107. C. *gigantea*. Rudge.
Muh. no. 31. Ell. no. 31.
Trans. Lin. Soc. VII. tab. 10, fig. 2.
Rees' Cyc. no. 170.
C. *lucustris* β *gigantea*, Pursh.

Spica staminifera unica vel pluribus; spicis fructiferis tristigmaticis ternis cylindraceis sublaxifloris remotis, suprema sessile, inferioribus exserte pedunculatis, fructibus globoso-ovatis conicis longo-rostratis nervosis inflatis glabris bifidis divaricatis, squama oblongo-ovata vel ovato-lanceolata duplo longioribus.

Culm nearly two feet high, triquetrous, glabrous; leaves broad, lanceolate, longer than the culm, rough (Muh.) scarcely scabrous on the edges (Ell.) bracts very long, leafy, glabrous; staminate spike single (Ell.) one or more (Muh.) three (Rudge) with ovate and acute, or lanceolate and acuminate, scales; pistillate spikes about three, cylindric, large, somewhat loose flowered, distant, sometimes staminate above (Ell.) highest sessile, lower exsertly pedunculate, erect or lax; stigmas three; fruit globular-ovate, long-rostrate, conic, inflated, nerved, two cleft, glabrous; pistillate scale ovate and acute or oblong-lanceolate, sometimes nerved, white on the edge, about half as long as the fruit.

Flowers in April and May—grows in marsh-like places S. Carolina—Rudge, Muh. and Ell.

This plant has not been found in the Northern States. Described as it is by Muh. and Ell. who were familiar with it, and with C. *lacustris*, which it resembles, there seems to be little reason for believing the correctness of Pursh in making it a variety of the latter. It appears to be a distinct species between C. *lupulina* and C. *lacustris*.

108. C. *lupulina*. Muh.
Muh Pursh, Eaton, Pers. no. 117.
Ell. no. 30. Schw. and Torrey no. 70.
Schk. tab. Ddd fig. 123 and Iiii fig. 194
C. *lurida*, Wahl. no. 75.

Spica staminifera solitaria erecta gracili subsessili; spicis fructiferis tristigmaticis ternis et quaternis ovato-oblongis crassissimis vel oblongo-cylindraceis brevi-pedunculatis erectis densifloris approximatis, inferiore sublongo-exserte pedunculata et interdum distante; fructibus ovato-conicis ventricosis longo et conico-rostratis bicuspidatis nervosis glabris, squama ovato-lanceolata acuminata subtriplo longioribus.

Culm 2—3 feet high, triquetrous, leafy along its length, subscabrous above; leaves lanceolate, rather broad, striate, flat, scabrous on the edge, longer than the culm, with striate sheaths; bracts leafy, large, much surpassing the culm, with short sheaths above; staminate spike single, sometimes two (Muh.) long, triquetrous, sessile or nearly sessile, very slender in proportion to the pistillate spikes, with lanceolate scales long-acute and scabrous on the point, whitish on the edge, sometimes distinctly three nerved; pistillate spikes, three or four, an inch to two inches long, ovate-oblong, very

thick, or oblong-cylindric and less in thickness, approximate and subsessile, sometimes the lower more remote and often rather long exsertly pedunculate, erect, densely flowered; stigmas three; fruit ovate-conic, ventricose, long rostrate and round, bicuspidate, nerved, glabrous, divaricate; pistillate scale ovate and acuminate, or ovate, lanceolate, often three nerved, about one third the length of the fruit. Colour of the plant a bright but not deep green—sometimes rather yellowish.

The figure in this Vol. shows a common form of this species; if the lower spike be supposed to be wanting, the fig. shows the C. *lupulina* of most authors.

Flowers in May—grows in marshes and about ponds—common.

The pistillate spikes of this large and beautiful species differ much in length. Often they greatly resemble the fruit of the common *Hop*, Humulus *lupulus*, from which the species received its name;—often they are much longer, and of less diameter than the shorter. The figs. in Schk. are not very excellent; that on tab. Ddd shows a common form of the spike,—while that on tab. Iiii represents a rare variety in which the fruit is much more ovate and inflated *at the base* than is common. It is not clear that this fig. was not drawn from a specimen of C. *retrorsa*, Schw. in which the fruit was only in a small degree reflexed. The reference of C. lurida, Wahl. in Rees' Cyc. to C. *intumescens*, Rudge, is doubtless incorrect.

β. *polystachia*, Torrey. Spicis fructiferis quinis perlongo-cylindraceis, infime remota et longo-pedunculata.

This variety chiefly differs in the greater length and number of the spikes, which are commonly five, and often nearly three inches in length. The fruit is not quite so much inflated—leaves wider, ensiform, nearly half an inch wide—bracts very large and leaf-like, often exceeding a foot in length. Large as are the spikes usually, on this variety they are gigantic.

Flowers in May and June, in swamps, on the high lands, Phillipstown, N. Y.—Dr. Barratt.

Note. Figures of the following species accompany this paper, and are given in this volume. They are not drawn by the same hand as the preceding, but they illustrate finely the several species.

Tab. H. fig. 24 C. rosea		
	β. radiata	Vol. X. p. 276
	25—Davisii	X. p. 279
	26—alba	
	β. setifolia	X. p. 280
	27—nigro-marginata	X. p. 282
I. fig.	28—gracillima	VIII. p. 98
	29—squarrosa	VII. p. 270
	30—pyriformis	IX. p. 69
K. fig.	31—cristata	X. p. 44
	32—scabrata	IX. p. 66
	33—blanda	X. p. 45
L. fig.	34—Cherokeensis	XI. p. 160
	35—Muskingumensis	X. p. 281
	36—retrorsa	IX. p. 67
	37—lupulina	XI. p. 165

ART. XV.—*Contributions towards the Botany of the States of Illinois and Missouri;* by LEWIS C. BECK, M. D. Professor of Botany, Mineralogy, &c. in the Rensselaer School.

(Continued from Vol. X. p. 264.)

PENTANDRIA. MONOGYNIA.

Myosotis arvensis *Lin.*

Stem 4 to 6 inches high, simple. Barrens near St. Louis —May.

Myosotis virginiana *Lin.*

HAB. Alluvion of the Mississippi opposite to St. Louis— June—August.

Myosotis lappula *Lin.*

HAB. Road sides and on the banks of the Riv. des Peres—May—July.

Batschia canescens *Mich.*

Stem and *Leaves* villous. *Flowers* terminal and lateral; somewhat fastigiate—*Corol* orange yellow. The root affords a beautiful reddish crimson lac, which is much in use among the natives.

HAB. Common from St. Louis to Fort Clark on the Illinois—April—May.

Pulmonaria virginica *Lin.*

The western specimens of this plant differ from the eastern, in having narrower leaves and smaller flowers.

HAB. Banks of the Illinois—April.

Onosmodium hispidum *Mich.*

HAB. High exposed situations near Cahokia (Ill.)—May.

Lycopsis arvensis *Lin.*

Whole plant very densely covered with whitish hairs. *Leaves* much shorter than in the eastern specimens.

HAB. Barrens near St. Charles on the Missouri—July.

Phacelia fimbriata *Mich.*

HAB. Inundated banks of Streams near St. Louis—Also on the banks of the Illinois—May—June.

Hydrophyllum virginicum *Lin.*

HAB. Banks of the Mississippi, near St. Louis—May.

Hydrophyllum appendiculatum *Mich.*

Filaments perfectly smooth. *Peduncles* much longer than the leaves. In these it differs from the description of Dr. Torrey.

HAB. Found in company with the two last—May.

Ellisia nyctelea *Lin.*

HAB. On the inundated banks of the Illinois river—rare—April.

A very fetid plant about 6 inches high, with a light blue corol.

Dodecantheon Meadia *Lin.*

HAB. Prairies near St. Louis, and on the Sandy Bluff of the Illinois river—April—May.

Samolus valerandi *Lin.*

HAB. Margins of creeks aud brooks—common in different parts of Illinois and Missouri. June.

Lysimachia ciliata *Lin.*

HAB. Woods near St. Louis. June.

Convolvulus sepium *Lin.*

HAB. Near cultivated grounds, St. Louis. July.

The leaves are much smaller than in any of the eastern specimens which I have seen. In other respects the western plant appears to agree with the former.

Ipomæa purpurea *Lamk.*

HAB. In company with the last. July.

Phlox paniculata *Lin.*

Stem 2—3 feet high. *Flowers* in very large, numerous corymbs. A highly ornamental species.

HAB. Woods south-west of St. Louis. May—June.

Phlox divaricata *Lin.*

Stem nearly erect, hairy above. *Leaves* ovate-lanceolate, opposite, closely sessile, distant, hairy on both sides. *Flowers* few, in a terminal scattered panicle. Segments of the *calyx* erect, subulate-linear, half as long as the tube of the corol. *Corol* purple; tube nearly straight; segments obcordate, wedge-form.

HAB. Banks of the Illinois. April—May.

My western specimens have the teeth of the calyx shorter; and the whole plant more hairy than in those from this state.

Phlox pilosa *Ell.*

HAB. Banks of the Illinois, in company with the last. April—May.

My specimens of this plant agree precisely with the description of Mr. Elliott. It is supposed, by Mr. Nuttall and Dr. Torrey, to be the same as P. *aristata;* but I have no means of satisfying myself of the correctness of the opinion. P. *pilosa* has a stiff *stem*, which is generally erect, and pubescent on every part. *Leaves* revolute on the margins. Segments of the *calyx* subulate, nearly as long as the tube of the corol.

Phlox bifida.*

Stem 4—6 inches high, erect, branching, minutely pubescent. *Leaves* about an inch in length, ovate-lanceolate, or lance-linear, somewhat clasping at base, opposite and alternate; margins revolute, and with the midrib ciliate. *Corymb* few-flowered. Segments of the *calyx* linear, acute, hairy, more than half the length of the tube of the corol. *Corol* purple; tube nearly straight; segments wedge-form, deeply cleft, sometimes nearly to the base. *Style* as long as the tube of the corol.

HAB. On the banks of the Illinois near Fort Clark. April. A large flowered species, which can be easily distinguished by the characters above given, and particularly by the deeply cleft segments of the corol.

Polemonium reptans *Lin.*

HAB. On the low alluvions of the Illinois and Mississippi. April.

Solanum carolinense *Lin.*

This unsightly plant is well described by Dr. Torrey, in his Flora. The star-like pubescence is very characteristic. Mr. Elliott remarks that the corol is obscure, but in those specimens which I have seen, it was large and quite showy.

HAB. Road sides and beaten grounds near St. Louis. June.

Physalis pubescens *Lin?*

Whole plant white pubescent. *Leaves* fleshy, somewhat viscous, alternate. *Calyx* pubescent in every part, nearly the length of the corol.

HAB. On the rocky banks of the Mississippi. May.

Verbascum thapsus *Lin.*

HAB. Road sides and beaten grounds, every where in Illinois and Missouri. May—June.

Campanula perfoliata *Lin.*

HAB. Alluvions of the Riviere des Peres. May.

Triosteum perfoliatum *Lin.*

HAB. Woods near St. Louis—rather rare. May.

Vitis œstivalis *Lin.*

Hab. Banks of the Mississippi, north of St. Louis. July.

Cissus hederacea *Pers.*

Hab. In similar situations with the last. June.

Viola cucullata *Ait.*

Hab. On the prairies from St. Louis to Fort Clark—very common. March—April.

Viola palmata *Lin.*

Hab. Barrens near St. Louis. May. Very variable, and perhaps only a variety of the last.

Viola pedata *Lin.*

Root fasciculate. *Leaves* numerous, many-parted, pedate; divisions lance-linear, entire or subentire.

Hab. Banks of the Mississppi, near Alton, Illinois—rare. April—May.

Viola blanda *Willd.*

Hab. Wet woods on the Riviere des Peres, 5 miles west of St. Louis. April.

Viola pubescens *Ait.*

Hab. In company with the last. April.

Viola bicolor *Pursh.*

Hab. On the Mammoth mound a mile north of St. Louis, and not elsewhere. April.

Claytonia virginica *Lin.*

Hab. Low alluvions of the Mississippi and Illinois. April. The leaves vary considerably in width.

Ceanothus americanus *Lin.*

Hab. On the Barrens in various parts of Illinois and Missouri. Common. April.

Euonymus atropurpureus *Jacq.*

Hab. On the alluvions of the Mississippi and other streams in the vicinity of St. Louis. May. It attains the

height of 8 or 10 feet, and is quite branching. *Flowers* tetrandrous.

Comandra umbellata *Nutt.*
HAB. On the prairies near St. Louis. April.

Impatiens pallida *Nutt.*
HAB. Banks of streams Illinois and Missouri. July.

Ribes recurvatum *Mich.*
HAB. Woods near St. Louis. April—May.

PENTANDRIA DIGYNIA.

Apocynum cannabinum *Lin.*
Stem 2—3 feet high. *Leaves* ovate or oval, mucronate, attenuate at base, with revolute margins, smooth and somewhat glaucous above, white pubescent beneath, on short hairy petioles. *Cyme* somewhat panicled. *Corol* small, green; tube rather shorter than the segments of the calyx.
HAB. Banks of streams near St. Louis. June.

Apocynum hypericifolium *Ait.*
Stem 2 feet high, branching. *Leaves* oblong, tapering at both ends, (never cordate) very acute, hairy beneath, on short petioles. *Cyme* many flowered, paniculate; panicles erect. *Calyx* about as long as the tube of the corol.
HAB. Gravelly banks of streams. Missouri. June.
This species resembles the last, but differs from it in having the leaves smaller, narrower, and tapering each way from about the middle; and also in having its inflorescence more distinctly paniculate. There is, however, some confusion concerning the species of this genus.

Asclepias syriaca *Lin.*
HAB. Rocky banks of the Mississippi at St. Louis. June. This plant sometimes attains the height of six feet. It is comparatively rare in these states. I have never observed it on the prairies.

Asclepias quadrifolia *Jacq.*
HAB. Prairies near St. Louis and elsewhere in Ill. and Miss. June. The western specimens have the *leaves* more

fleshy, somewhat pubescent beneath, ciliate on the margin. *Flowers* white and pale red.

Asclepias incarnata *Lin.*

Stem branched above. *Leaves* 3—5 inches in length, smooth, lanceolate-oblong, cordate at base, on short petioles. *Umbels* numerous. *Flowers* purple.

HAB. Wet prairies and exsiccated ponds. July—Aug.

Asclepias amœna *Lin.*

Stem sparingly branched above. *Leaves* oblong, tapering at base, acute or acuminate, whitish pubescent beneath. *Umbels* few.

HAB. In similar situations with the last—July.

Asclepias verticillata *Lin.*

Leaves varying from 1 to 3 inches in length, and from 2 to 4 lines in width. *Umbels* verticillate towards the upper part. *Flowers* purple.

HAB. Prairies and barrens near St. Louis—July.

Asclepias obtusifolia *Mich.*

HAB. Open prairies west of St. Louis. May. The whole plant, and particularly the flowers, are larger than on the sea coast.

Asclepias longifolia *Mich.*

Stem 2 to 3 feet high, erect, simple, very hairy. *Leaves* 3 to 4 inches long, scattered, narrow-lanceolate, obtuse, thick, scabrous, covered on both sides with short stiff hairs, revolute on the margins. *Umbels* lateral, on short peduncles. *Pedicels* very numerous, hairy. Leafets of the *nectary* shorter than the antheridium, distinctly cucullate; *horn* wanting. *Corol* green.

HAB. On the Prairies near St. Louis, and St. Charles. June.

This plant belongs to the genus *Acerates* of Elliott; which differs from *Asclepias* principally in the absence of the horn-like processes of the nectary. But this character appears to be common to several genuine species of *Asclepias*; as A. *syriaca*, A. *phytolaccoides*, &c. Mr. Nuttall and Dr. Torrey seem to think that A. *longifolia* is not specifically distinct from A. *viridiflora* of Pursh. I have only a single

specimen of the latter from the eastern States, which differs from the former as follows. The flowers are larger and much less numerous. *Leaves* oblong-ovate, acute, (resembling those of A. *amœna.*) Leafets of the *nectary* erect, not cucullate.

Asclepias tuberosa *Lin.*

Var. cordata.* *Leaves* broad, cordate at base.

HAB. Sandy prairies west of St. Louis—rare. June. Agrees in every respect with A. *tuberosa*, except in the leaves, which are about three fourths of an inch in breadth, and cordate at base.

Anantherax viridis *Nutt?*

Root perennial. *Stem* 2 to 3 feet high, smooth, sparingly branched, deeply grooved. *Leaves* 3 to 4 inches long, scattered, oblong, very obtuse, with a mucronate point, thick, minutely pubescent on both sides, with revolute margins, on short petioles. *Umbels*, terminal, few-flowered. *Pedicels* an inch long, slender. *Calyx* persistent, erect, five-parted; segments ovate-lanceolate, hairy beneath. *Corol* erect, green, campanulate; segments ovate, sub-acute, three or four times as large as the leafets of the calyx. *Nectary (Lepanthium* Nutt.) simple, five-parted; segments compressed, closed both above and below, incurved, longer than the antheridium, without horns.

HAB. On the Siliceous hills near the lead mines, in company with *Œnothera alata.* May—June.

This plant certainly belongs to the genus *Anantherax* of Nuttall, but it does not altogether agree with his description of A. *viridis*. According to Mr. Elliott *Asclepias connivens* of Dr. Baldwin, *(Anantherax viridis* Nutt) has the leafets of the nectary (stamineal crown of R. Brown,) with short horns,

Heuchera viscida *Pursh.*

HAB. Prairies near St. Louis. July.

Sanicula marilandica *Lin.*

HAB. Fertile alluvions of the Mississippi and other streams—common. May. Highly esteemed by the natives as a remedy for the bite of poisonous snakes. The leaves are beaten to a pulp and applied externally to the wound.

Sium tricuspidatum *Ell.*

Stem 2 or 3 feet high, very smooth, sparingly branched. *Leaves* pinnate, 3 or 4 pairs, with an odd one. *Leafets* lanceolate, acute, somewhat rigid, from 2 to 4 toothed; teeth unequal. *Involucrum* caducous.

Hab. Swamps west of St. Louis. June—July.

According to Mr. Elliott this is S. *rigidius* of Walter, and differs from S. *rigidius* of Linnæus, in the leaves, which are almost 3-cuspidate, and in the seeds, which are more slightly winged.

Thaspium aureum *Nutt.* } Hab. Wet grounds
Thaspium barbinode *Nutt.* } near St. Louis—May.

Myrrhis canadensis *Nutt.*

Lower *leaves* sometimes nearly biternate. General *involucre* wanting; partial one consisting of one or two short almost subulate leaves. *Styles* persistent, erect, at length divaricate.

Hab. Shady alluvions of the Illinois and Mississippi. June.

Myrrhis longistylis *Torrey.*

Stem hairy at the joints and near the root. *Umbels* with 3—5 rays. Lower *leaves* sometimes on long petioles. *Styles* linear, subulate, long.

Hab. In company with the last. June.

The only distinctive character of this plant is the length of the styles; if this is constant, it is perhaps sufficient to warrant its erection into a new species. The other characters noticed by Dr. Torrey are very variable, both in the eastern and western specimens. Dr. Bigelow, in the last edition of his Flor. Bost. also divides M. *claytoni* of *Mich.* but his descriptions are quite different from those of Dr. Torrey.

Smyrnium cordatum *Walt.*

Hab. Wet grounds—common. May.

Smyrnium integerrimum *Lin.*

Hab. In company with the last.

Cicuta maculata *Lin.*

Hab. On the banks of streams, in several parts of these states. June.

Erigenia bulbosa *Nutt.*

Hab. Banks of streams near St. Louis. March 15th.

Ulmus americana *Lin.*
Ulmus fulva *Mich.*

Hab. Both these species are found upon the banks of streams throughout Illinois and Missouri. The former, however, is by far the most common. The variety with pendulous branches is to be met with on the Illinois.

Celtis occidentalis *Lin.*

Hab. Banks of Riviere des Peres, 5 miles west of St. Louis. April.

PENTANDRIA. TRIGYNIA.

Viburnum acerifolium *Lin.*

Hab. This species is found, in company with V. *Oxycoccus*, on the alluvions of the Mississippi near St. Louis. May.

Rhus glabrum *Lin.*
Rhus toxicodendron *Lin.*
Rhus aromaticum *Ait.*

Hab. These three species are found in woods near St. Louis. June. Mr. Nuttall remarks that R. *aromaticum* is the only species to be met with in Upper Louisiana;—but this is a mistake.

Sambucus canadensis *Lin.*

Hab. Fields near St. Louis. May.

Staphylea trifolia *Lin.*

Hab. Banks of Riv. des Peres. April. This tree rises to a considerable height.

HEXANDRIA. MONOGYNIA.

Tradescantia virginica *Lin.*

Hab. Prairies and barrens near St. Louis. May.

Hypoxis erecta *Lin.*

HAB. Prairies, every where in these states. May.

Allium striatum *Willd.*

Scape from 8 to 12 inches high, naked, compressed. *Leaves* radical, linear, nearly as long as the scape, striated on the outer surface. *Spathe* 2-leaved, about 6-flowered. *Corol* spreading large, white. *Petals* ovate, with a prominent coloured midrib.

HAB. Timbered alluvions of the Mississippi near St. Louis—rare. April.

Phalangium esculentum *Nutt.*

HAB. On the prairies of Illinois and Missouri—common. May.

Dr. Torrey has given a very minute and accurate description of this interesting plant. See his Flora, p. 346.

Lilium canadense *Lin.*

Stem 2—3 feet high, smooth. *Leaves* whorled, broad lanceolate, acute, 3—5 nerved. *Flowers* from 1 to 3, nodding, on peduncles which are four or five inches in length.

HAB. Prairies near St. Louis. June.

Lilium Catesbæi *Walt.*

Stem 12 to 18 inches high, smooth, round. *Leaves* lance-linear; one whorl of 4 or 5 near the flower; the rest scattered. *Flowers* large, scarlet spotted with brown. *Petals* tapering into a long claw at base, acute, (not acuminate.)

HAB. In similar situations with the last. June.

Erythronium albidum *Nutt.*

Leaves impunctate. *Flowers* reflexed, white or bluish white. *Petals* lance-linear and somewhat obtuse, nearly twice the length of the stamens. *Stigma* trifid.

HAB. Banks of Peoria lake, near Fort Clark. April.

This species has the inner petals without dentures; but this is also the case with some yellow flowered specimens in my herbarium. These last may belong to the species which Mr. Nuttall mentions as allied to E. *albidum.* They were found in the vicinity of Albany, and may be more particularly noticed hereafter.

Uvularia lanceolata *Willd.*

HAB. High bluffs of the Illinois river. April.

Differs from U. *perfoliata* as follows: *Petals* lanceolate, smooth within. *Anthers* without, or with very short, awns. *Pistil* shorter than the stamens. The whole plant is larger, the flowers much more showy and of a deeper yellow. I have never observed it on low grounds.

Smilacina racemosa *Desfont.*

HAB. Woods, prairies, and alluvions near St. Louis. May.

HEXANDRIA. TRIGYNIA.

Melanthium virginicum *Lin.*

Stem 4 to 5 feet high, erect. *Leaves* sheathing at base, 12 to 18 inches long, carinate. *Stamens* of the length of the petals.

HAB. On the prairies 3 miles south of St. Louis—very rare. June.

This is one of the largest herbaceous plants that I have seen. The inflorescence resembles that of *Veratrum viride*, although the panicle is much larger and more branching.

Helonias dioica *Pursh.*

HAB. On the prairies in Miss., Ill., and Ohio. April.

Trillium viride.*

Root perennial. *Stem* 8 to 12 inches high, smooth. *Leaves* ovate, acute, somewhat tapering at base, closely sessile, 3 to 5 nerved, with whitish spots on the upper surface. *Flower* erect, closely sessile. Leafets of the *calyx* lanceolate, ovate or lance-linear, an inch and a half long, erect, obtuse, broad at base. *Petals* dark green, fleshy, narrow, somewhat spatulate, a little longer than the calyx. *Stamens* half the length of the corol.

HAB. Shady banks of streams, St Louis. May.

The form of the calyx leaves is very variable. In one of my specimens it is nearly ovate.

Trillium recurvatum.*

Stem 8—10 inches high, smooth. *Leaves* ovate lance-ovate or obovate, nerved, smooth, clouded with darker green,

sessile or on very short petioles. *Flower* closely sessile. Leafets of the *calyx* an inch long, lanceolate, acute, recurved. *Petals* purple, of the length of the calyx, lance-ovate, very acute, attenuate at base, erect. *Filaments* very short.

HAB. In similar situations with the last. April.

This may be *Trillium sessile* of Linnæus; but its flowers differ considerably from that species as described in botanical works and as figured in Curtiss. At all events '*sessile*,' is now no longer a distinctive character and should be changed. In addition to the above sessile flowered species of this genus, it is probable that at least two more have already been discovered.

Trillium erectum *Lin.*
Var. album *Pursh.*

HAB. Rocky banks of creeks emptying into the Illinois—common. April.

Trillium grandiflorum *Salisb.*

HAB. On the prairies of Illinois. May.

In the spring of 1822, I observed this plant in flower, at intervals, from St. Louis to Cleaveland on the Ohio, and also in the western part of this State.

Rumex acetosella *Lin.*

HAB. Prairies—common. April.

Rumex britannicus *Pursh.*

HAB. Swampy grounds near St. Louis. April.

HEXANDRIA. POLYGYNIA.

Alisma plantago *Lin.*

HAB. Swamps 5 miles west of St. Louis, and elsewhere. June.

HEPTANDRIA. MONOGYNIA.

Æsculus glabra *Willd.*

HAB. On the banks of the Illinois and elsewhere. April.

OCTANDRIA. MONOGYNIA.

Rhexia virginica *Lin.*

HAB. Banks of the Merrimack, 16 miles south of St. Louis—rare. June.

Œnothera biennis *Lin.*

HAB. Prairies and woods near St. Louis. June.

Œnothera sinuata *Lin.* ?

Root woody, perennial? *Stem* 8 to 12 inches high, somewhat branching, villose. *Leaves* oval-oblong, toothed and sinuate, sometimes almost pinnatifid;—lower ones subentire, petioled. *Flowers* small, axillary and terminal. *Calyx* villose; segments reflexed, one third the length of the tube. *Petals* red, obcordate, as long as the segments of the calyx. *Capsule* an inch or more long when mature, linear, angled; angles very villose.

HAB. On the mounds near St. Louis. May.

I am in great doubt whether this is Œ. *sinuata;* but I have not at present the means of comparison. The long capsule, the still longer tube of the calyx, and the red corol, do not appear, judging from the descriptions of Mr. Elliott and Dr. Torrey, to belong to that species. Should the above prove to be distinct, I would propose the specific name *villosa*, in reference to the calyx and capsules. I also found in the vicinity of the above a dwarf variety, characterized as follows: *Stem* 2—3 inches high, simple. *Leaves* an inch long, oval, entire. *Flowers* terminal solitary. It differs from Œ. *minima* *Psh.* in the length of the tube of the calyx, which is nearly an inch. The corol is reddish yellow.

Œnothera macrocarpa *Pursh.*

HAB. On the siliceous hills near the lead mines, Miss. May.

This splendid species was first discovered by Mr. J. Bradbury, in the above situation, to which it appears to be peculiar. I have never seen it in any other place In my specimens the capsules are not so large as is stated by Mr. Nuttall; being seldom more than an inch and a half in length, and half an inch in breadth.

Gaura biennis *Lin.*

HAB. Wet grounds near St. Louis. July—August.

Epilobium coloratum *Muhl.*

HAB. Banks of small streams near St. Louis. August.

Acer saccharinum *Lin.*
Acer negundo *Lin.*

HAB. These two species are found on the alluvions of the Riviere des Peres and other streams. April.

OCTANDRIA. TRIGYNIA.

Polygonum punctatum *Ell.*
Polygonum mite *Pers.*
Polygonum pennsylvanicum *Lin.*
Polygonum virginianum *Lin.*

HAB. The above species are quite common on the margins of swamps near St. Louis. June—July.

Polygonum aviculare *Lin.*
Polygonum convolvulus *Lin.*

HAB. Near cultivated fields. July. In the latter species the lobes of the leaves are very acute.

Polygonum amphibium *Lin.*

HAB. Margins of ponds. July. A distinct species from P. *natans* of Eaton.

ENNEANDRIA. MONOGYNIA.

Laurus sassafras *Lin.*
Laurus Benzoin *Lin.*

HAB. Both species are quite common on the banks of the Illinois. March—April.

DECANDRIA. MONOGYNIA.

Cassia marilandica *Lin.*

HAB. Banks of creeks near St. Louis. July.

Cassia chamæcrista *Lin.*

HAB. Barrens and prairies west of St. Louis. June.

Baptisia alba *R. Brown.*

HAB. High sandy prairies, from St. Louis to Potosi.—June.

Cercis canadensis *Lin.*

HAB. Inundated banks of streams in Illinois and Missouri—common. March—April.

DECANDRIA. TRIGYNIA.

Cucubalus stellatus *Lin.*

HAB. Prairies, Illinois and Missouri. June.

Silene regia.

Stem erect, 2 or 3 feet high, branched, with tumid joints, and, as well as the whole plant, pulverulently pubescent and viscid. *Leaves* broad-ovate, opposite, scabrous; lower ones sub-clasping; upper acuminate. *Flowers* scarlet, large, in pairs, or in threes, at the extremities of the branches, numerous. *Calyx* an inch long, cylindric, 10-striated. *Petals* oblanceolate, generally entire.

HAB. Hills near the Potosi lead mines—rare. June.

Stellaria longifolia *Muhl.*

HAB. Banks of the Riv. des Peres. May.

DECANDRIA. PENTAGYNIA.

Cerastium vulgatum.

HAB. Fields—common in these two states. April.

Cerastium nutans *Raf.*

HAB. Rocky banks of streams. May—June.

Oxalis violacea *Lin.*

HAB. Side hills on the Illinois river—rare. April.

Oxalis corniculata *Lin.*
Oxalis stricta *Willd.*

HAB. Prairies—common. May. The former is about a foot long, procumbent, hairy. The flowers are smaller than those of the last.

Penthorum sedoides *Lin.*

HAB. Margins of ditches and swamps, St. Louis. June.

(To be continued.)

ART. XVI.—*Description of the Grevilleanum Serratum, a new genus, belonging to the order Musci.* BY LEWIS C. BECK, M. D. and EBENEZER EMMONS, M. D. Read before the Albany Institute.

GREVILLEANUM.

GENERIC CHARACTERS. *Seta* terminal. *Peristome* double; outer teeth 16, broadish, acute; inner 64, subhorizontal, somewhat bent, free at the apex. *Calyptra* glabrous, opening laterally; base tubular, sheathing the neck of the capsule; apex closed, acute.

This singular and distinct genus is named in honour of Dr. Robert K. Greville, of Edinburgh, author of the Flora Edinensis, and one of the most distinguished muscologists of the present day. It can be easily recognized by the characters above given. The numerous teeth of the inner peristome are always distinct at the base, but in the young state they cohere slightly at the apex, where they appear to be held together by transverse bars, which separate as the capsule becomes mature. The calyptra is closed at the top, and has a short mucronate point. Its longitudinal opening is scarcely more than one-third of its whole length; through which the capsule escapes while in a very young state. Its base forms a sheath, which closely embraces the neck of the capsule and summit of the seta. When, however, the capsule becomes old, the calyptra, still sheathing the seta, falls down to the base of the latter, and there remains among the leaves.

G. *Serratum.* Stem erect, simple. Leaves linear-lanceolate, acute, crisped when dry. Lid hemispheric, yellow, without a beak. Capsule cylindric, curved, subhorizontal. Teeth of the peristome yellow.

HAB. Rocks in shady places, a mile west of Troy.

Stems about an inch and a half in height, simple, bearing a considerable resemblance, in habit, to a Bartramia. Leaves numerous, nearly half an inch in length, crisped and rigid. *Seta* dark chestnut brown and shining.

Explanation of Figures.*

A. Top of the Peristome, magnified. B. Capsule and Calyptra, magnified. C. Calyptra, magnified. D. A Leaf, magnified. E. Whole plant, natural size.

* In striking off the figures, *in colours*, it was not convenient to represent the following shades, described in a letter from the author :—" Top of the peristome near gamboge yellow—calyptra light green—capsule a shade darker."

Art. XVII.—*Observations on two late Meteors seen at New-Haven.* By Alexander C. Twining, Civil Engineer, &c.

[Communicated to the Connecticut Academy.]

Early in the evening of March 31st, a brilliant ball of light was seen at this city, passing in a westerly direction, and at a considerable height above the horizon. This was followed on Saturday evening, (April 1st) by a second, which passed more to the south. The first passage took place at half past seven o'clock, and was seen by numbers. The second was at nine, or a few minutes earlier. It attracted less notice than the first, but was described by an observer as commencing near a point lying N. 30° E., and in altitude 60°, continuing till it reached the zenith, where it disappeared. After its disappearance, there was left a luminous track through the whole course, which remained for about a minute. In about two minutes a sound was heard which was taken by the observer for thunder; but no cloud appeared. The same thing was witnessed by a gentleman at Arlington, 18 miles north of Bennington, in the State of Vermont, who gives the following statement of the circumstances: "He was riding towards the west, when a sudden light around him caught his attention, and, turning he saw a fiery ball that shot from north to south. In the south-east it vanished, about 30° above the horizon. Its duration was short, but, three times in its course it seemed to stop and instantly to leap forward with a tremulous motion. Its course was marked by an arch of light, at which he remained looking till a shock reached him much like thunder, one minute and a half, according to his judgment, after the disappearance of the *meteor*." From these observations it would seem that the height, at the time of the meteor's vanishing, was at least 60 miles; since a distance of 110 miles to the north depressed its altitude 60°. Conclusions, however, are uncertain which, in cases of this kind, rest on the impressions of but two or three individuals; but as the first observation was made under circumstances which ensure a nearness to the truth, and as the other was made by one who judges with correctness of astronomical distances, the height conjectured may be considered an approximation to the true one.

The first meteor, however, was seen by many, whose remarks being compared, may lead to results nearly accurate; and such as are known will be given as they were collected. As the same phenomenon was witnessed at Salem and Andover in Mass. and at Arlington, where the appearance of the second has been already described, it will be singular if similar observations have not been made and brought together at some other places through so extensive a tract of country.

" Two gentlemen walking down Chapel street, New-Haven, were startled by a sudden light around them, which cast shadows like the moon. They next saw a mass of light over a house just before them, and thought that one of the chimneys was on fire. They were so situated as to see the whole passage of the body from this time till it vanished. Its colour was a dazzling white. It threw off sparks in its course, and was followed by a train, three or four degrees long. One of the two having conducted the writer to the spot, and pointed out the place where it was first seen, and some parts of its course, by the aid of material objects around, the altitudes were measured, and the following observations noted:

In azimuth S. 16½ E. its altitude was 42°
,, S. 53½ W. ,, 20°, where it disappeared.

The duration of the passage was conjectured by the observer, to be a quarter of a minute; but being requested to follow its course with his finger, as it actually appeared, he passed it in six seconds; and, on his relating the circumstance which took place from the flash to the disappearance, it seemed, probably, near the truth.

Mr. J—— H—— of New-Haven, being so situated as to see the whole phenomenon, describes it as commencing its course east of south, rising but gently, and vanishing far south of west. At the end of the course there separated from it several parts which seemed to fall. After looking at the whole he walked to a considerable distance, and then heard a report sudden and of short continuance. Being requested to walk again over the same ground, and with the same speed, the interval was four minutes and a half. Following, with his finger, the course, he described a duration of twelve seconds. From his description, taken on the spot of observation, the following particulars were noted:

	Az. S. 26½ E.	Alt.	15°
Place of vanishing	,, S. 36 W.	,,	25°

Mr. ——, a master mechanic in New-Haven, hearing his family speak of the flash of light, went out to wait for the report. From circumstances it seemed likely that five minutes passed before the sound was heard. He describes the sound as shaking the pavement.

Mr. B——, a student of Yale College, was sitting in his window, when the flash was seen. The meteor was concealed by a large building; but he noted where the shadow from the upper part of the roof fell, and the line which it pursued on the ground. The duration seemed to his recollection five seconds; but tracing its course along the ground, it amounted to no more than three. The observations derived from this source are—

Az. S. 12 E. Alt. 43°

Course of shadow ,, S. 76½ E.

E. H——, an intelligent lad, first saw it over a large building. It seemed to 'move level,' as he expressed it, and he described about the place of vanishing. It seemed about as large as the moon. At its vanishing it went out gradually, and after it was gone, there appeared immediately three bodies of a red colour falling, but partaking of its motion. They were traced in their fall two or three degrees. Its course, measured by his finger, was between five and six seconds.

Az. S. 34½ E. Alt. 19°

Place of vanishing ,, S. 56½ W. ,, 26°.

Mr. N. J——, also saw the whole phenomenon. A mass of light, irregular, and as large as the moon, appeared to the east of south-east. It vanished south of west. Walking onward he heard a heavy sound, which he took for thunder, and looked for the cloud. It was sudden, and repeated, in the manner of a reverberation. Being requested to walk over the ground at the same rate, the interval was four minutes and a third. Following, with his finger, its course, the duration was four seconds.

Az. S. 69½ E. Alt. 9°

Place of vanishing ,, S. 66 W. ,, 22½°.

Three persons were walking in an open space and saw the body at the same moment. They agree with regard to the phenomena, particularly the place of disappearance. One of them, a lady of close observation, describes it as flying like a rocket, and with a similar train. There seemed to her an interval between the mass and the train, as if a dark body

were moving on, followed and surrounded by flame. It was in size very much less than the moon, as the others described it, about one third in diameter. The spot of vanishing was pointed out. At the time of bursting and disappearance it threw off sparks which seemed to fall. She judged the duration to be five seconds, and this agrees very exactly with what can be gathered from the conversation which passed.

Place of vanishing S. 57 W.

From these different accounts, the following particulars may be gathered: The meteor seen on the 31st of March, made its appearance at some point far east of south. In azimuth S. 12 E., its altitude was 43°, and it vanished between S. 50 W. and S. 60 W., at an altitude of 23°. Its form was not regular, but approaching to round, and its apparent magnitude much less than the moon's. Its colour was white, tinged with blue. Throughout its course it threw off sparks, and was followed by a train a few degrees in length. At the end of its course it exploded and threw off parts which were seen to fall*. The sound of the explosion reached the ear in 4 minutes 25 seconds after the vanishing of the meteor. The same body was seen north of Boston and as far as Vermont. Its whole course occupied about 5 seconds.

From the interval between the explosion and the report, and from the suddenness of the passage, it is obvious that 60 miles from the observer would lie but little beyond its distance at the moment of explosion, and that 24 miles a second, would not exceed its velocity. Its nearest distance to the earth's surface may have been within 30 miles, or even less. As to its magnitude, no very definite conclusions can be made. Those which have usually been given, in such cases, as amounting to probability, have doubtless exceeded the truth. They would have applied more correctly to the size of the body and the surrounding flame; at least, these remarks will apply to those which, like the one under consideration, do not indicate, by the regularity of their outline, a process merely of ignition. How often this case has occurred, the writer does not know. The universal attendance of a train brilliant and long, and sometimes of one which remains after the body is gone from sight, is a strong argument, in *all* cases, for a flaming medium around the mass of

* There can be little doubt that these were *meteoric stones* which have fallen somewhere in the southern part of New-York, in New-Jersey, or, possibly, in Long-Island Sound.

matter. Or, let any one measure, in his mind, a distance of 20 miles, and a duration of one second, and then let a globe, some portion of a mile in diameter, pass along the distance in that time, and through an atmosphere even of very diminished density, it will not appear surprizing that, by the power of friction, the excitement of electricity, and the compression of air, it should surround itself and mark its course with flame. The existence of a compressed and luminous atmosphere might also account for the apparent stops and sudden leaps forward, which these bodies are often said to make.

In the present case the different representations of magnitude vary from 10′ to more than half a degree. If we place it at 15′, and consider that of the body 10′, we shall have 56 rods, or one sixth of a mile, for the diameter of the meteor.

The existence of these bodies in the form of revolving masses of matter is now generally admitted. That it should have been so long discredited by philosophical observers, and considered as embarrassed with difficulties, is perhaps an instance of the common fact, that the simplest theories are the last received. But though so near and so frequent in their appearance, they are probably the last with which, in many important respects, we shall be acquainted. Their phenomena and motions are too rapid and transient for the steady observation of science, and it is only from common observers that we can generally expect any account of them. Still, such accounts ought to be carefully collected, and such observers to know that their opportunities may be made of use to philosophy.

The circumstances which the observer should be prepared to notice are these: The time of occurrence, the place of rise and of vanishing, and any points of its course, especially if it pass material objects, which can be marked, together with the place of observation. The aspect of the body and its train. The duration of the course. The kind and intensity of the report, and the interval of time between the report and explosion. Other observations may be both useful and interesting, though these seem, at present, to be the principal.

But if ever the phenomena shall become settled and known, and every fact disclosed which rational curiosity can search out respecting these bodies, there will remain a question of principal interest to be answered: what beneficial purpose do they promote? Their numbers and the general

similarity of their directions seem to intimate an useful design in their formation, and mark them as controlled by some system. Still, as we often find, in regions of fertility, barren mountains of which no account can be given, so in the heavenly spaces there may be bodies whose existence can be explained in no other way, than as a mere casual result of those laws under which it pleased the Creator to place our system at its formation.

New-Haven, April, 1826.

INTELLIGENCE AND MISCELLANIES.

1. *Notice of Mr. Owen's Establishment, in Indiana—in a letter from William Maclure, Esq. to the Editor, dated*

New-Harmony, March 16, 1826.

Dear Sir,

Your letter of the 18th of January is received, and agreeably to the request therein contained, I shall give you a sketch of the moral and physical state of this settlement. Our geological productions are without variety, consisting of some of the latest sand-stones and a few coal measures, covered by a rich and productive alluvial. The plants have not yet passed within the reach of our observation, and 4 genera, and about 25 to 30 species of fresh water shells, in the Wabash, are the only animals as yet examined, that afford any interest.

We have been here scarcely two months, making a few experiments of the effects of the new system upon our species. From the obstinacy of old deep rooted habits, not much can be expected from theorising for so short a time upon subjects, with respect to which, as regards nine tenths of mankind, only practice can produce conviction. Still every thing considered, (both the materials and opportunities,) we have succeeded better than we had any reason to expect. We have found that it is much easier to assimilate a few, having the same pursuits, than many having different occupations,

by which they had been accustomed to live. The knowledge of each other, necessary to diffuse that confidence which is the main spring of social order in communities, was much easier created among a small number of friends, of much the same trade and profession, than in a mixture of callings, the relative ways of which, in the individual system, were too different to be at first easily reconciled to their former opinions of their own interest. Besides the scale was too extended, in large communities, for the comprehension, and beyond the limits of the sphere of calculation of the greatest part of the productive labourers, for whose benefit the social system has been adopted, and on whose support it must chiefly depend.

It was, therefore, decided (as the easiest and most certain mode of carrying into execution the social system) to divide into small communities the land surrounding Harmony, and already two societies are formed; one with 1200 acres of good land; the other with 1100 acres, at $3,60 cents and at $5 per acre, 7 years credit being allowed, and 5 years afterwards to pay it; 1-5 of the sum being paid per year. An advance was made of from 500 to 1600 dollars cash, to begin with, and 5 per cent. interest charged until all is paid. The condition is annexed, that the said land will always remain in joint communities and never be divided into individual property, under the penalty of forfeiture. In order to annihilate every temptation to speculation, any surplus that may remain, after supplying all the wants of the community, is to go, towards forming other similar communities. These terms being so reasonable, and the vicinity of this place offering such immense advantages for the education of children, and furnishing every supply on better terms than can be procured elsewhere, warrant us to expect, that very soon, the whole land about New-Harmony will be settled upon the same conditions.

The obstinate prejudices of men against making any useful or radical change (for the insignificant change of the cut of a coat or cap, although contrary to all common sense, is adopted with avidity) has, for a long time, prevented me from putting in practice, what I would have called experimental farming schools, for the education of the children of the productive classes: and this sociable system of Mr. Owen, offering all the means and materials for effecting the same reform amongst the same useful class, I have joined him in all his undertakings, on this side of the Atlantic, and we

intend to carry them into execution, as far as a considerable capital will permit. Already part of the boys' school is so far organized that they make shoes for themselves, and will soon do it for the whole community. They will likewise have work-shops for tailors, carpenters, weavers, &c. in the school, all of which trades will be alternately practiced, by way of recreation from their mental labour of Arithmetic, Mathematics, Natural History, &c. as a useful substitute for gymnastics; to which will be added agriculture and gardening. We have nearly 400 children belonging to the society, besides strangers from the different parts of the Union. The girls are taught the same things as the boys, by Madam Fretageot, and are classed, alternately, to work in the cotton and woollen mills, and in washing, cooking, &c. (for no servants are permitted in the society, and every one must do something for himself,) not working above half a day on any one kind of labour, thereby alleviating the fatigue by variety.

Youth of both sexes have been unjustly treated by forcibly enjoining on them tasks to perform as useless and unnecessary, as they were beyond their comprehension, and so different from all the occupations of men whom they saw daily employed on operations which they were prevented from following, or imitating, by their parents or instructors. The strong propensity to imitation, which, if indulged, would make education the apprenticeship of life, is crushed and crossed, rendering their time a burthen to them, and augmenting their misfortunes in the same ratio as their utility is diminished. My experience does not permit me to doubt, that children, under proper management, can feed and clothe themselves by the practice of the best and most useful part of their instruction; and in place of being a burthen, they would be a help to all connected with them.

The schools here will be on such a scale, as to location, men of talent, and perfection of machinery, as to constitute them the first in the Union, for every species of useful knowledge. Freed from the whims and caprices of custom, as well as that slavish admiration of antiquity, that bounds our exertions to copying the imperfect attainments of our forefathers, they will proceed improving every day, and endeavour to bring the mental faculties nearer to a par with the physical inventions.

All children, as well as men, if not occupied in doing good, will most probably be doing harm, either to themselves

or others. Want of occupation is one of the great sources of mischief. Children ought never to be idle, but to be constantly employed from morning to night in benefiting themselves or others. All our vacations are injurious to youth, and only serve the caprice or pecuniary interest of the masters, by prolonging the time necessary, and of course augmenting their salary, for instruction. Occupation should be so varied, as not to fatigue attention, and the mental and physical labour so balanced as not to injure the health. None of our species can be too long kept at work; there is nothing more easy than by habit to turn all useful and necessary occupations into an amusement, when life itself would become a pastime.

2. *Topaz of Connecticut.*—In the preceding number of this Journal, (Vol. X. p. 352) the existence of this locality of topaz, was announced, accompanied by a description and analysis of the mineral, by Professor Edward Hitchcock, and Mr. B. D. Silliman. We have it now in our power to state, that, although the vein has not been, (as we are informed,) penetrated, more than two feet, considerable numbers of the topazes have been found, and they are beginning, as might be expected, to lose their weathered and unsightly appearance, and to assume more purity, lustre, and beauty. When it is considered, that the effects of weathering often penetrate deep into rocks, and especially into veins, it could not be reasonably supposed that these topazes, (should the vein continue to furnish them at increasing depths, of which there seems strong probability) should assume a fresh and perfect appearance, as to form, colour, lustre, and soundness, until a depth is attained, beyond the effects of the ordinary meteoric agents. We have not visited the spot since the discovery of the topaz there, but the specimens brought by Mr. Lane, for inspection, abundantly confirm the opinions already expressed as to the nature of the mineral, and are interesting to the eye of a mineralogist, although still too imperfect, for the views of the lapidary or jeweller.

Crystals are lying before us varying in their dimensions from $2\frac{1}{2}$ inches to $\frac{1}{10}$ of an inch.* Numbers are aggregated laterally, and dispersed in portions of mica and quartz, and other contents of the vein. The colour is sometimes yellow

* Huge coarse crystals of the weight of several pounds continue to be found.

or yellowish, or reddish yellow, like that of the Brazilian and Saxon topazes, but more generally this topaz is nearly or quite colourless, like the topazes of New-Holland and Siberia, and *the fragments* are often perfectly limpid, so that in thin slices, they are as transparent as the most perfect glass or rock crystal, and when laid upon writing it is perfectly legible through them.* The cross fracture, at right angles to the axes of the prisms, is invariably foliated, and the substance is neatly divisible into thin slices, with *two* smooth, parallel, and highly brilliant and polished surfaces. This is seen, in a degree sufficiently conspicuous, in the most ordinary and weathered specimens, when broken at right angles to the axis, and in the more perfect ones, the brilliancy of these interior surfaces is not surpassed by that of any substance whatever. The same structure and brilliancy are often observed in fragments, that do not present any external geometrical form.* The fracture, in all other directions, than that which has been described, is conchoidal; sometimes flat and sometimes perfect, and deep, and having the wrinkled appearance, usually characteristic of that variety of fracture, when most perfect. The conchoidal surfaces are likewise brilliant, and scarcely yield in lustre, to the foliated faces; the lustre is highly vitreous and sometimes verges towards the adamantine.

Two or three years since, Dr. Brewster of Edinburgh transmitted to us an interesting printed paper,† on the "Distribution of the colouring matter and on certain peculiarities in the structure and optical properties of the Brazilian topaz." In this paper (exhibiting that precision and delicacy of observation so characteristic of its author) the most important circumstance is the description, and exhibition in coloured figures, of some remarkable coloured images and regular pictures observed in the plates of the topaz which are parallel to its natural foliated joints, and at right angles to its axis. Our object in adverting to this paper, at this time, is to say, that although, owing probably to the imperfection of the specimens, and the want of any *precise* observations, those *regular* dispositions of colour, corresponding with the external and internal form and structure of the crystals, have not

* Through *inclined* surfaces, there is a distinct double refraction.

† Communicated by him to the Cambridge Philosophical Society, and extracted from their Transactions for 1822.

been demonstrated—we have observed intense beauty of prismatic colours thrown from the interior of the Connecticut topaz, constant in certain positions, but not observable in others. The leading colours, which are very pure and intense, are blue, green, and red, sometimes in spots, but often in parallel lines, remarkably distinct, and much less blended at their confines, than those of the solar iris.

Additional researches are to be made in the vein and the result will be communicated to the public.

3. *Dana's Epitome of Chemical Philosophy.*—A work of 220 pages 8vo. cannot be expected to present much that is new in a science so extensive as chemistry.

The author's object is "to furnish a work which should be useful as a text-book of the science, as it is usually taught in our academies and colleges," and he has endeavoured "to comprise the principal facts and doctrines of chemistry, in a condensed form, adapted to the use of those who wish to acquire a knowledge of the PHILOSOPHY OF THE SCIENCE, without entering into the details of laboratory practice, or being encumbered with the minutiæ of processes, and descriptions of substances, which are interesting only to the professed practical and operative chemist."

Dr. Dana appears to have executed his design with good judgment, and we doubt not that his work will be useful to learners, especially to those who wish to treasure up principles, with the omission of details.

We have so many elementary chemical works, and so many good ones, that it can scarcely be considered as necessary to compile any thing new, except for the precise purpose of illustrating a course of lectures, and for this purpose every lecturer has undoubtedly the right to publish his own views and arrangement, for the benefit of his pupils and of others who may choose to adopt them.

Dr. Dana's arrangement is clear—his style neat and perspicuous—his selections judicious, and he has introduced the most important facts and observations that have been made in this country.

4. *Peach Trees.*—A practical nursery man, now in the office, requests us to state for the benefit of the public, that he has discovered the cause of the decay of our peach trees, and also how, effectually, to remedy the evil. The cause is

small grubs about an inch in length, that breed in the roots from nits deposited there the preceding season, and in the spring hatch and feed upon those roots, and after devouring the sap, then make their way up the body of the tree, nourishing themselves as they proceed till they advance two or three feet, when the root ceases to supply them, and then they die and the tree dies with them. Now for the remedy, which has never been known to fail. As soon as the buds begin to put forth and the leaf to appear in the spring, and before they are quite out, remove from the bottom of the tree entirely all the dirt or turf till you come to the bare roots, from which scrape all the loose, old rotten bark; then take three quarts of fresh slacked lime for a large and full grown tree, and so in proportion for a smaller and younger one, and lay it carefully on and about the roots, covering it from the weather, and it will destroy these destructive maggots entirely.—*N. Y. Eve. Post.*

5. *Unprecedented Cold.*—PLATTSBURGH, Feb. 22, 1826. On Tuesday and Wednesday of last week, was the coldest weather probably ever experienced in the United States. We did not ascertain how low the thermometer sunk in this place; but at Fort Covington, fourteen miles distant, a thermometer sunk to 40° below zero, and the mercury froze! How much lower an alcohol thermometer would have sunk, is not known; probably, however, not more than one or two degrees, as mercury exposed at the same time, was a long time in congealing. A degree of cold, sufficient to freeze mercury was never before noticed in the United States, and probably never in so low a latitude as 45. The coldest weather that we recollect to have heard of in this country, was 32° below zero.—*Intelligencer.*

6. *The heat of July* 1825, seems to have been as oppressive in England and France as in this country, and to have been attended in some instances, with the same fatal effects, as a number of sudden deaths are mentioned in the papers. The thermometer stood at Bath on the 19th, in the shade, at 89 degrees; and the number of horses that had died, is supposed to be greater than at any former period. The effects of continued hot weather were seriously felt. Brooks and ponds were become quite dry, and vegetation was suffering from the scorching heat of the sun. The weather in Paris

was most intensely hot, and such a season has scarcely ever been remembered there. Nearly a period of twelve weeks elapsed without a single drop of rain, and the papers represent the country as absolutely burnt up. The thermometer of Fahrenheit was daily as high as 90 degrees, even in cool parts of the city, and was in many places between 90 and 100 degrees throughout the day. The waters of the river Seine were extremely low indeed.

7. *Sea Serpent.*—Capt. Holdrege, of the ship Silas Richards, which arrived yesterday from Liverpool, states that in passing George's Banks, five days since, he had a fair view of the sea serpent. It was about ten rods from the ship, the sea perfectly calm, and that part which appeared out of water about sixty feet in length. The head and protuberance were similar to the representations which have frequently been given of him by persons who had seen him near Cape Ann. He was going at a very slow rate, and appeared unmindful of the ship. He was visible about seven minutes to the passengers and crew, who were on deck at the time. A certificate has been drawn up and signed by the passengers, which, with a drawing made by one of the gentlemen, gives a minute description of the serpent as seen by them. The number and credibility of the witnesses, place beyond all doubt the existence of such an animal as a sea serpent.—*New-York Advertiser, June* 21, 1826.

8. *Reliquiæ Diluvianæ. Hayden's Geological Essays. Eaton's Survey.*—A letter from Prof. Buckland to the Editor, dated Paris, March 1, 1826, states, that this gentleman was then on his way to the South of France, Italy and Sicily, for the purpose of continuing his researches on the diluvial deposits in those parts of Europe, before the publication of a second volume of the Reliquiæ, for which the author has amassed a large store of materials from England. He is very desirous to be informed as to the contents of our vast caverns in the west and south-west, and mentions with much interest Mr. Eaton's proposed examination of certain caverns, in the state of New-York and elsewhere.

For the sake of promoting the very interesting researches of Professor Buckland, and of fortifying his conclusions, which must increase in importance, the more the scenes from which the evidence is drawn, are diversified and extended,

we would urgently solicit all those intelligent persons who have access to our caverns, especially in the great limestone formations, to cause the loose earthy materials on the floor of those caves, to be explored for bones, and if any are found to have them carefully preserved and examined, and the facts reported. Wherever extensive excavations have been already made, for the purpose of obtaining nitrous earths, it is respectfully suggested that the workmen should be interrogated, and their refuse materials inspected with care. We look to our scientific friends in the western and south-western states and colleges, for the influence and efforts necessary to this research. Professor Buckland regards Dr. Hayden's Geological Essays, as a work of much value in relation to his researches into the facts connected with the American diluvial formations; and Mr. Eaton's survey on the great canal, as "a valuable addition to our geological knowledge," and as tending to "confirm our expectation of the universality of the general order of superposition."

Mr. Buckland mentions that a letter from Professor Savi of Pisa, had just given him information of the existence, in the limestone of the neighbourhood of Carrara and the gulph of Spezzia, of caves containing bones of bears, hyænas, &c.; he was about proceeding without delay to investigate the facts.

9. *Collections of Foreign Minerals.*—Foreign minerals in collections, more or less extensively labelled, described, and classified, may be obtained of FREDERIC MOLDENHAUER, at HEIDELBERG, Germany. The editor has received from him a letter, which states, that he will furnish collections, either for money or in exchange for American minerals: the prices and particulars may be learned by the perusal of a printed catalogue, which has been transmitted by M. Moldenhauer, and which the editor will loan. Mr. Leonhard, private counsellor and professor in the university of Heidelberg, is stated to have recommended the channel of communication with this country, which is now indicated.

10. *Antiseptic influence of Chlorine and of its compounds —in a letter from* M. Laisné *to the Editor, dated Paris,* 1825.—The daily and varied application of the chlorates of lime and soda*, made at Paris by Dr. Lisfranc, chief

* The celebrated antiseptic of M. Labbarque, parmaceutist of Paris.

surgeon of the hospital de la pitié, has been attended with a degree of success, far surpassing the hopes which had been conceived by several other learned practitioners, who had employed this powerful chemical agent in medicine. Mr. Lisfranc has cured, in the course of a few days, very large ulcers, which had been unsuccessfully treated by the common methods. He has also had the satisfaction to succeed equally well with recent burns, especially with the severe sores of the greater part of those who were wounded at the burning of the manufactory of Livry, near Paris.

This important object tends more and more to produce new developements and learned explanations, in the course of instruction, which he (Dr. Lisfranc) gives at the amphitheatre Broussais, near the Sorbonne.* In the instructions published by M. Labbarque, he announces that he is occupied upon an extended work, "upon the decomposition of animal substances and its influence upon animated beings." All enlightened men wait with impatience for this work, in which the connexion of our physical and chemical knowledge in relation to this subject will be illustrated, by all the light which physiology affords. It suffices for simple common sense to glance at the precious advantages of these new researches and of this new labour. The truest and most brilliant glory which belongs to medical science is connected with this subject, and we no longer perceive in this sanctuary an illusive fame and vain and fruitless pretensions—"une famée déceptive"—"une expression vaine et insignificante."

The numerous facts stated by learned bodies and particularly by the Institute of France, have proved the disinfecting and curative efficacy of the chlorates.

The public authorities have been constrained by conviction to adopt them in practice†—every day the most learned practitioners make new applications of them in the healing art, and with peculiar propriety, in cases where medicine has hitherto been imbecile, particularly with respect to contagious diseases. It is evident, that the use of the chlorates is the best prophylactic remedy against these maladies, and that, either alone or almost alone, they have arrested their

* "A l'amphithéâtre Broussais, enclos des Jacobins Saint Jacques près la Sorbonne.

† "Voyez la *Revue Encyclopedique* de Juillet and Août et les Journaux de medecine de la même époque, publiée a Paris."

effects in individuals who were infected and near being destroyed by them.

It follows of course, that only a step is necessary to destroy every established seat, every potential and every active cause of these maladies, in bodies either organized or not: to arrive at the chemical demonstration of this cause neutralizable by a chemical agent, at the discovery of the system or of the organs, by means of which this deleterious cause attacks animal life.

FURSI LAISNÉ, Professor
of the Russian Language, rue du petit Vaugirard,
No. 1, à Paris.

Remarks by the Editor.—M. Laisne's letter was forwarded under the expectation that it would be published, and with a promise of other communications, which he wishes to have made known to the learned societies of America—"especially to the academy of natural sciences of Philadelphia, and to the honourable Mr. MACLURE."

The pamphlet of Mr. Labarraque has been transmitted to us by the kindness of Mr. Laisné. It appears that the disinfecting powers of the chlorates are so great that if there be occasion to disinter and examine a corpse, which is already in a state of putrefaction, the odour disappears, provided a cloth moistened with the diluted chlorate be placed upon the body, and it will be necessary to sprinkle the cloth from time to time.*

If putrescent fluids have run upon the ground, their odour is destroyed by pouring the diluted chlorate on the place, and stirring it with a broom; by dashing it upon porticoes, stair-cases, &c. which are infected, a similar effect is produced.

Vaults, privies, sewers, &c. are cleansed in a similar manner.

Did our limits permit, all the statements in relation to this subject, contained in Mr. Laisne's letter might be corroborated by particular cases; only a few can be alluded to. The contagious effluvia emanating from diseased persons, are

* A particular case of this kind is related, where, for some judicial purpose, a body which had been buried one month, was disinterred by order of government, in August, 1823: it was offensive, and during the ten hours that it remained above ground, before the persons arrived who could certify its identity, it became very much inflated, and the stench was insupportable. The application of the chlorate of lime produced a wonderful effect—the smell ceasing almost from the first aspersion.

completely destroyed by sprinkling the chamber with one of the liquid chlorates, very much diluted with pure water; it should be dashed about the beds; and physicians and attendants should moisten their hands and their nostrils with the liquid.

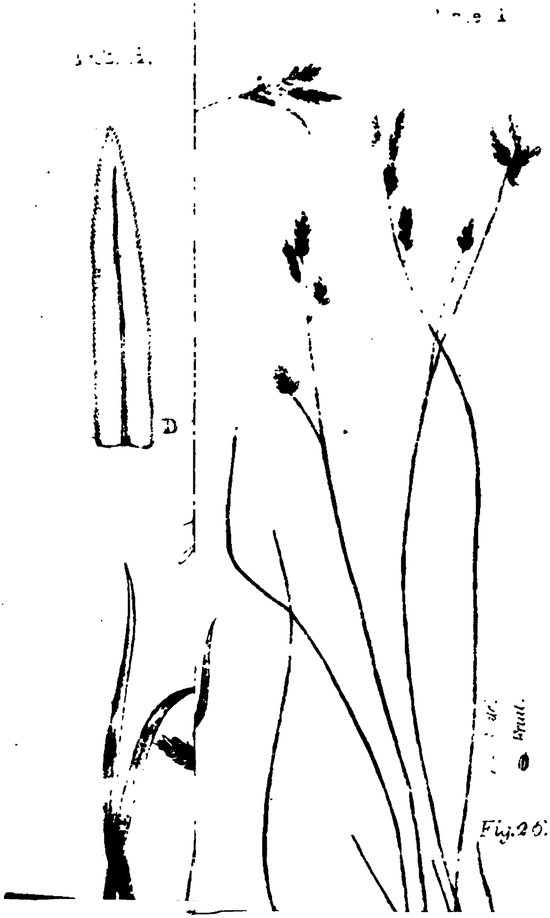
These agents remove the odour of foul teeth and gums, and neutralize the dangerous emanation from the ulcerated sore throat. A purulent and offensive discharge from the bladder was removed by injections of a very dilute chlorate. Bodies kept for interment until they are offensive, may be rendered innoxious by these fluids, and professional men, called to examinations connected with medical jurisprudence, with processes of embalming, or with demonstrations in anatomy, should secure themselves by a free use of these powerful agents.

They neutralize the foul air of marshes, of markets, and other places where animal matters occasion a putrid and deleterious effluvium.

The common sewer in Paris, called Amelot, being entirely obstructed, had been for 40 years a nuisance. In 1782, eight men were suffocated in an attempt to cleanse it, and in a recent effort several workmen had fallen down in a state of asphyxia; when the attempt was again made, and with entire success, and without accident. The safety of this painful and dangerous operation appears to have been imputable entirely, to the use of the chlorate of lime, with which the workmen wet their hands, arms, and nostrils, and also all the putrescent matters which they were removing. The superintendant derived his safety from a disinfecting bottle, which he occasionally applied to his nostrils. The space to be cleared was from ten to fourteen feet long, the putrescent matters formed a bed of four feet and a half in thickness, and the labour occupied more than four hours.

One of the workmen who had been thrown into a state of asphyxia, in the attempt to enter the vault without precaution, and who had lain forty-eight hours in this situation, entirely without sense, was completely restored by the use of the chlorate of lime, inhaling the odour, receiving the fluid internally, and having it sprinkled in his chamber.

M. Labarraque's preparation is called in the French memoir *chlorure de oxide de sodium et de chaux*, and the method of preparing it is given in Tome I. des Archives générales de médecine."



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AMERICAN

JOURNAL OF SCIENCE, &c.

Article I.—*The Divining Rod.*

Observing men have long been perplexed with the divining rod, that common discoverer both of salt water and fresh, and of minerals and ores in the bowels of the earth. Those who at once laugh at its pretensions and always laugh at them, make light of the perplexity, without taking a step towards its removal; while those who have paid any attention to the subject, find facts irreconcilable with any known and established laws of nature; and, also, reasonings contrary to known laws and to common sense. If the laws of the divining rod be an absurdity, it is equally an absurdity that honest men should combine to maintain a poor falsehood.

Since the eleventh century, the divining rod has been in frequent use. It was first employed "for the purpose of finding metals and minerals, and for the discovery of stolen property, and to identify characters guilty of crimes." Justice coming to be better understood, the divining rod lost credit as a witness of moral turpitude, and now claims, and has long since only claimed, to find metals and ores and fountains and veins of water below the surface of the earth.

More than one English writer has spoken kindly of the esteem in which it is held by the miners of Britain. In France, so late as 1781, a volume was published, 'detailing 600 experiments, made with all possible attention and circumspection, to ascertain the facts attributed to the divining rod; by which is

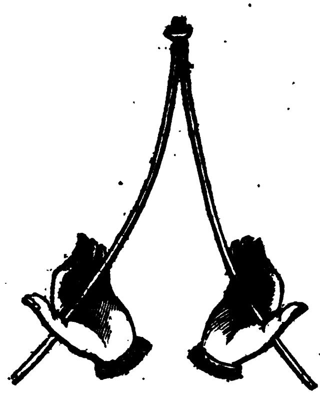
unfolded their resemblance to the admirable and uniform laws of electricity and magnetism.'

We find in our own country, many decided friends of the divining rod. Our public journals not unfrequently contain letters of respectable correspondents, stoutly maintaining its character for truth and integrity.

It is a subject of eager curiosity to some, and is not perfectly understood by any. It admits of being explained to the most moderate capacity; and it is hoped this paper will furnish every reader both with facts and arguments, to sustain him in right views of the divining rod, and to enable him to disprove the false.

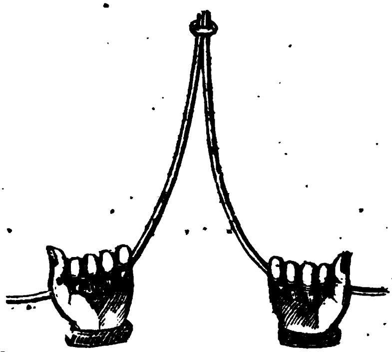
It begins with a description of the rod, and a general notice of the present state of the art in our own country.

The divining rod is a forked branch of any tree whose bark is smooth and whose fibre is very elastic. The witch hazel is in the highest esteem, not merely for its potent name, but also for the convenient size and ready forks of its plenteous branches, and the uncommon elasticity of its fibre. The peach and the cherry are often used. The limbs of the fork should be 18 inches or 2 feet in length, and of the diameter of a pipe stem. When used, it is taken thus:



the palms of the hands being turned upwards. But when the diviner, apprehending the action of the hidden influence,

begins to grasp the rod firmly, the fingers are drawn tightly upon the rod, and it takes this form:



the limbs of the rod being bent from their middle to their lower extremities outward. The diviner, holding the twig carefully in this manner, moves onward with a slow and creeping step. In due time the head of the fork turns downwards, and, coming to point perpendicularly to the earth, marks the site of the fountain or ore.

The action of the rod under these circumstances, is a fact plain to the vision of every beholder. Those who hold it, are oftentimes men in whose hands we would without hesitation intrust life, property and reputation: and no doubt they are wholly unconscious of the power, which excites the action of the rod, but they confidently believe it proceeds from hidden fountains, or minerals in the bowels of the earth. From north to south, from east to west, the divining rod has its advocates. Men in various callings, men above the reach of mean arts, men of the soundest judgment, of large information, and of the most exemplary lives, do not disown the art, and when a friend demands their aid, rarely if ever, is it made the means of extortion by the meanest professor. Literati and Doctors, in want of fountains for their domestic use, do not disdain to call for the demonstrations of the divining rod, and will, in some instances, acknowledge the accordance of the results with the previous declarations of the diviner.

If there be a fraud, the diviners themselves are the first deceived, and the greatest dupes. But how can they be deceived? They hold the rod steadily in both their hands—in the diagram, the point of the rod is turned towards the heavens.

In searching, the rod discovers its sensibility by the motion of the point from its vertical position downward through the arc of a semicircle, until it rests perpendicular to the earth. This motion, so far from being intended by the holder of the rod, is made in opposition to the closest grasp his hands can give. And although an honest man's word might be taken for this, we have the fact corroborated by our own senses. We can see, and if that be not enough, we can also feel the rupture of the green bark, as it is fairly wrung from the rod, in the contest between the force which bears the point of the rod down, and the pinching grasp of the diviner, to prevent that motion.

The rod does not exhibit this unaccountable action in the hands of every man. Many, all, *can urge* it to exhibit this motion; while it is only in the hands of a very few that it is supposed to move not merely without urging, but contrary to their best efforts.* These few are of no peculiar age, constitution or habits, to distinguish them from their fellow-men. But if any female has ever exercised the gift of divining by the witch hazel, it has not come to the knowledge of the writer.

Diviners are sensible of no change in their feelings, while the rod acts. They determine its nearness to some attracting body, as every beholder may, solely by the demonstration of the rod itself. The only peculiarity I have heard commonly remarked, is, that the rod acts more freely in hands naturally moist, than in hands naturally dry—a mechanical effect which oil would probably increase.

In New-England, where springs are most abundant and always pure, the use of the art is less frequent, because less necessary. In the states south and west, where water is not equally abundant, and fountains are not so certainly pure, the art is better known and more highly valued. The water hunter obtains celebrity. He is sent for to a great distance, and performs wonders with praiseworthy modesty, and for a moderate compensation.

In all parts of the land, if the diviner hunt for metals, he becomes distrusted by the better sort of men. Yet the persuasion is general, that the rod is influenced by ores; and this persuasion is the diviner's greatest defence. For in pursuit of water, if he direct the search at a wrong place, he is

* One writer says: With the precaution of washing the hands and soles of the feet in a weak solution of muriatic acid or salt and water, and making the trial barefooted, the experiment will succeed with every one.

excused without loss of confidence, upon the discovery of any mineral or vile ore in sinking the well. Traces of iron ore are almost universal in that part of our country, where the divining rod is in the highest repute; and often serve effectually to conceal the diviner's entire defeat.

But the divining rod does not merely point out the site of the hidden fountain: it determines also its depth. This part of the science is equally wonderful and important. To know that water may be obtained by digging at a particular spot, is not enough. We must know more; that the fountain is within a reasonable depth. Accordingly, all men gifted with the use of the divining rod, have a way to determine the depth of the newly discovered fountain, if it be within fifty feet of the earth's surface. Thus the inexplicable motions of a green twig in the hands of a rare man, serve, in the opinion of many, to point out the situation of a fountain in the midst of the dry land, and to ascertain its depth; and to point out veins of salt water with precision from 300 to 600 feet below the surface of the earth. The thing is incredible; and it is equally incredible that the best men in the land should falsely maintain that the motions of the rod in their hands are entirely contrary to their own well-meant efforts.

In 1820, I was at the residence of a respectable farmer in Ohio, and again in 1821, where I noticed a new well at an inconvenient distance from the house. I inquired why that spot had been chosen for a well. The farmer replied, that it had been selected by the divining rod. "Ah! and who carried the rod?" He named the father of a large family, one of thirteen brothers, and respected throughout the country. Here was food for curiosity. The well was but 7 or 8 feet deep, a triumphant witness to the power of the divining rod.* On learning further that the rod marked perfectly well in the hands of one of the farmer's eight sons, I obtained leave to take him with me, and make experiments. The lad was about 12 years of age, and his character of a diviner was established, where that of a prophet is last allowed: in his own family and among his own kindred. His youth was no reasonable objection to his possessing a peculiar natural gift; and I hoped now to determine, whether the *cause* of the mo-

* No sign of a fountain, discoverable to common view, existed at the spot before sinking the well. The diviner told the precise depth it would require to reach the water: so said the farmer.

tion of the divining rod lies above or below the surface of the earth.

We first prepared divining rods from every species of shrub and tree in the forest, the orchard and the garden, to determine the kinds of wood which are most apt for divining. We then repaired to the grass-plat, in which the new well was situated; for there the rod, when held by experience, had already designated the situation and general course of three veins of water, which the lad might retrace with more certainty, than he could designate a new fountain. A swift brook runs on one side of the enclosure.

The first experiment was to know, whether the rod would exhibit its singular movement in my hands. It would not. The next was to find what notice it would take of water running above ground. The lad held the rod naturally by its limbs parallel to the surface of the swift brook. But the point made not the slightest dip to discover its affinity for water. Then the lad held the rod in the diviner's manner, sometimes standing in the water, and continued standing on stones raising him above the water. After many trials with contradictory results, the boy thought that the brook attracted the rod in some degree, but not so much as a vein of water under ground.

We next turned to the hidden veins of water, on one of which the new well was situated. No one has ever supposed that the attraction between the rod and hidden fountain communicated through the eyes of the diviner. It was clear that these guides of his steps must be quite unnecessary to the lad in retracing the hidden water-courses, if I would gently lead him myself. For the rod is not an eye-servant, to fail of noticing its proximity to hidden fountains, because its master fails to watch its motions.

I explained my purpose to the lad, who readily consented to further it. He traced the three hidden veins over the space of an acre, while I, following close behind him with a heavy stick, tore off the light turf, and made a continued furrow along his course. While thus employed, I repeatedly asked him, if he surely found the veins as the aged man had done; and to his constant answer in the affirmative I replied, that any mistake now would render it impossible for him to retrace his path blindfolded.

This done, I blindfolded him so that he could not see,—took him lightly by the elbow, and led him away from the

furrow marking the vein of water on which the new well had been sunk. After a few steps, I turned with him, requesting him to hold up the rod for discovery. I guided him back, but he chose the time of every step. The rod began to turn, and, when having finished its circuit it turned perpendicular to the earth, he stopped. "Do you mean that the rod points exactly to the vein of water?" "Yes," he replied. And indeed it did: with his eyes he could not have pointed it better.

This was demonstration. Conviction could neither be resisted nor avoided. The sight of the new well had prepossessed me in favour of the divining rod. The experiment with the lad had been conducted fairly, and its result was irresistibly conclusive. It must convince every one: and to obtain a collection of facts which would put the question at rest forever, I continued the experiment. I led the lad to the next furrow, and the rod missed it. I led him back, and it missed again. I led him to and fro, across and then along his three furrows; and he failed incessantly. I tore off the turf at every new place, where the rod pointed out a fountain, and ceased not from discoveries, until the russet and bleached turf of the acre on which the experiment was conducted, became figured with black spots, denoting fountains every where. This was as it should be. There could be no mistake. The illusion of the fountains, and of all attraction under ground, vanished at once. The motion of the rod remained, but it must be accounted for some other way.

In all my experiments with diviners since, I have found them very shy of a blinder. No diviner has proved so traitorous to his own self-respect as to test the skill of the rod by depriving it of the light of his own eyes. One whose age and respectability obliged me to pay him deference, was pleased with the suggestion of trying the rod over running water above ground. Across a neighboring stream, a huge tree had been prostrated; its capacious trunk serving for a firm pathway over the swift waters. On this the good man crossed the brook, holding the divining rod properly in his hands. As he came over the waters, the point of the rod began to turn, but did not reach the end of its motion, until he had fairly crossed the stream, and stepped upon the opposite bank. In repeating the experiment, his own motions and those of the rod were better timed together. His conclusion, carefully drawn, was, that the rod was affected by running water above ground, but not so much as by water under ground.

He held the rod with peculiar spirit, and an air of determination. Hoping to catch his lively manner, I took a rod, as I stood on the bank of the rivulet, and tried my own hands again. I moved neither hand nor foot, but the rod was in action; neither could I restrain it. He who has held the Leyden jar in one hand, while, for the first time in life, he received its electric charge with the other, will recognize the sensation which communicated itself to the heart, when I felt the limbs of that rod crawling round, and saw the point turning down, in spite of every effort my clenched hands could make to restrain it. To my great satisfaction, without moving from the spot, I found the bark start and wring off from the limbs of the rod in the contest; just as the diviner often shews, to convince himself and his employer of the strong attraction of the discovered fountain. It was manifest that the force moving the divining rod is unconsciously applied by the hands of the diviner, and that the great art in holding the rod consists in holding it spiritedly. A smooth bark and a moist hand appeared to have a substantial connection with divining; and from that day to this the rod has never failed of moving in my hands, nor in the hands of those I instruct.

Take the rod in the diviner's manner, and it is evident that the bent limbs of the rod are equivalent to two bows tied together at one extremity; and, when bent outwards, they exert a force in opposite directions upon the point at which they are united. Held thus the forces are equal and opposite, and no motion is produced. Keep the arms steady, but turn the hands on the wrists inward an almost imperceptible degree, and the point of the rod will be constrained to move. If the limbs of the rods be clenched very tightly that they cannot turn, the bark will burst and wring off, and the rod will shiver and break under the action of the opposing forces. The greater the effort made in clenching the rod, the shorter is the bend of the limbs, and the greater the amount of the opposite forces meeting in the point: and the more unconsciously, also, do the hands incline to turn to their natural position on the wrists. And this gives true ground for the diviner's declaration: the more powerful his efforts are to restrain the rod, the more powerful is its effort to move.

It would be absurd to suppose, as he does, that the fountain or mineral increases its attraction, in proportion to the resistance he opposes to the motion of the rod induced by that attraction: and he never once suspects, that the very effort to

restrain the rod is so applied by the unnatural position of his hands, as to become itself the sole cause of the rod's motion. Let the diviner release his grasp, and the rod can no more turn itself in his hands, than the unbent bow can throw an arrow. By grasping the rod smartly, he strains the bows; and if the rod be small and elastic, and of a smooth bark, it will creep round in moist hands slowly and mysteriously.—But if the rod be large, and otherwise properly qualified, its limbs are too stout, and its motion, when smartly bent, becomes ungovernable. This renders a small rod essential to the diviner; a rod whose motions he can bridle, but not wholly overcome.

The motion of the divining rod forwards rather than backwards, is produced by the slight turn of the hands on the wrists *towards their natural position*. The rod may be mad with perfect ease to turn backwards rather than forwards, only by turning the hands still more upward. This motion of the hands on the wrists is not observed by the diviner, but if he mark the position of his hands in the commencement, and again at the end of the experiment, he will find it apparent.

Two large goose quills tied together at their tips, and held like a divining rod, are a fine test of the nature of this moving force. Two sticks of polished whalebone, flattened and joined at one extremity, form a perfect divining rod. The motions of these quills and bones are as perfect for the discovery of fountains as those of any green branch ever cut. Indeed, polished whalebone excels witch hazel itself in divining, as it is firmer, smoother, and more elastic. But polished whalebone has neither sap nor juices to be attracted by metals nor by fountains.*

The laws by which the depth of the discovered mines or fountains is supposed to be determined, are a curiosity sufficient to attract a moment's attention. There is something amusing in the oddity of their moonstruck features; but it is a sober and a melancholy sight to see a good man working by them, wise men confounded by the results, and the multitude inclined by the whole operation to trust in superstitious observances.

* Since writing this, I have learned that a professional gentleman, a most excellent man, and a well-known diviner, not many years deceased, commonly used a fork of whalebone for a divining rod.

The diviner, having ascertained the site of a fountain, and wishing to determine its depth, makes it a centre from which he retires to some distance, and returns again very slowly with the rod on the search. The moment the rod is perceived to move, he stops and marks the ground. He then retires from the centre in another direction, and carefully approaching again, he marks the ground where the rod is first moved by the supposed fountain. Repeating this several times for the greater certainty, he makes it appear that the rod is every where affected within a circle, whose centre is the site of the fountain; and the diameter of this circle is precisely twice the depth of the fountain required. If the water be 7 feet below the earth's surface, the rod will be affected in a circle of 14 feet diameter; but if the water be seven times seven feet deep, the rod will be affected in a circle seven times greater than the first. The attraction *extends* with the distance! It is absurd. The deeper the fountain lies, the sooner the rod will discover its existence! It is most unnatural. Moreover, the amount of the attractive forces is always just sufficient to draw the point of a rod through the arc of a semi-circle, and no more; whether the attractive forces be expanded throughout a circle of 100 feet diameter, or compressed into one 14 feet diameter. Then these forces ought to be very active, when the circle is reduced so as to bring the atracting bodies into near contact. But after they come in sight of each other, all mutual attraction ceases, and they remain at rest!

I am unable to say what law is used to determine the depth of salt-water fountains. That which remains to be noticed is more applicable to their case, than the law already expounded. It would extend the first rule too far for the simplest understanding, to suppose, that a salt-water fountain, 300 feet deep, would influence the divining rod in a circle of 600 feet diameter; and that a fountain 600 feet deep would influence the rod in a circle of 1200 feet diameter. This second law, however, was invented before salt-water fountains of that depth were discovered, and is extensively known to diviners, and for variety frequently used. It can be deduced from the manner of operation, which is this: the diviner holds the rod by the extremity of one of its limbs, extended over the discovered fountain or mine. In this situation the point of the rod is exposed to two conflicting forces, viz: the attracting body, and the elasticity of the rod. In the contest

between these, the rod vibrates, and the number of its vibrations is the depth of the attracting body, not in yards or inches, but in running feet!

Such are the laws of the divining rod; and such their boasted "resemblance to the admirable and uniform laws of electricity and magnetism."

Some good men will yet be reluctant to surrender the divining rod; to rank it among the monstrous births of the dark ages which yet survive. They will urge instances of its successful operation: they will assert, and perhaps prove, that fountains have been and are discovered according to the predictions of the diviner. They will take particular notice of the exactness with which the blinded boy struck the vein of water the first time, and be almost ready to suspect that the natural incertitude of mind, peculiar to one led about blindfolded, communicated itself to the divining rod, and caused its mistakes.

That the lad succeeded perfectly the first time, ceases to be a wonder, when it is recollected that afterwards he failed incessantly. Possibly he kept some count of his steps, to aid him in the first trial, and then became bewildered. He should be bewildered. He ought not to know north from south, but only that the ground he would tread on was safe. Then his mystical rod might have ceased to move, if it were not where the waters were. But it did move, and point most knowingly. And if the young fox had had his eyes, I doubt not that in fifty trials, the rod would have pointed more than twice in the same place.

I am not one to believe that a series of coincidences on the same point is often accidental. If fountains have been and are discovered according to the predictions of the diviner, (which I allow,) it is because, in this country, men can hardly fail of finding water in from 20 to 50 feet deep, any where: they cannot miss oftener than diviners actually do. That sometimes the diviner hits the truth closely, as in the case of my farmer's new well, I shall not deny, when others honestly assert the fact. But they do sometimes mistake altogether; and their failure being no wonder, is soon forgotten, while their success is matter of astonishment long to be remembered.

After a faithful and patient investigation, I know not the slightest ground on which the claims of the divining rod can be sustained one moment. I allow to the utmost, that the

motions of the rod take place contrary to the sincere intentions of the diviner. But the same force which he applies to restrain the motion, does, actually, from the peculiar manner of holding the rod, compel that motion. If the attraction between the rod and water be real, it will show itself, one would think, when the rod is held fast in the *diviner's* hands, in any position. This, however, is not the case. It requires a smart binding pressure of its limbs, together with an imperceptible turning of the hands on the wrists, to put it in action; and then the more you hold it, the more it will go. This singular conduct of the rod has imposed on diviners, and, mistaking its true origin, they have, with common consent, imputed it to ores and fountains in the bowels of the earth.

The whole character of the divining rod may be safely rested on the single experiment of blinding the diviner. Young or old, if guided solely by the divining rod, he could repeatedly trace the same courses blindfold, which he has before traced, always marking his veins and fountains of water in the same places, the rod would gain credit; but since he cannot, it must sink,—it must be forsaken.

The supposed laws of the divining rod are absurd. It goes blindfold when the diviner is blindfolded; and the cherry, the peach, and the hazel itself, are excelled in the subtilty of their divining motions by dry and nervous whalebone.

The pretensions of diviners are worthless. The art of finding fountains and minerals with a succulent twig, is a cheat upon those who practice it, an offence to reason and to common sense; an art abhorrent to the laws of nature, and deserving universal reprobation.

ART. 2.—*Observations on the Geological Features of the South Side of the Ontario Valley, in a letter to F. Romeyn Beck, M. D.* By JAMES GEDDES, Esq. Civil Engineer.

[Read before the Albany Institute, February 15, 1826.]

ALBANY, Feb. 1st, 1826.

DEAR SIR,

I had heard from geologists so much about the formation of every valley, by the action of waters flowing in vast torrents in times long past, that I was much pleased to find in the *Geological and Agricultural survey of the district adjoining the Erie Canal*, the following admission:—"We "are compelled to admit that hills, and valleys were formed "first, and that afterwards, water began to descend the in-"clining sides of the hills and to collect, or march onward "through the vallies." Page 153.

In the year 1810, from examinations of the country at, and east of the Niagara Falls, I was led to doubt the reasonableness of the conjecture, that had been so often hazarded; that the cataract of Niagara had in *time* travelled from near Lewiston to its present site.

Lake Erie is held to its present level by the stratum called Black Rock, a lime rock in which flint* abounds, the *endings* of which can be traced west and east to a great extent. North of, and below the termination of the stratum, the Chippewa runs to the east and the Tonawanta to the west, both streams emptying into Niagara between Black Rock rapid and the Niagara Falls. These streams are deep for many miles from their mouths, and the Niagara river, from Schlosser to Black Rock, may be considered as a lake, nearly. At the north of Navy Island, the water is from 40 to 50 feet deep, and at the place where the Welland Canal is proposed to leave the Chippewa the depth is 40 feet, which shews the stratum from which the great cataract is precipitated, dipping rapidly to the south, giving depth to this piece of water, as the stratum at Black Rock dips southerly and gives depth to lake Erie.

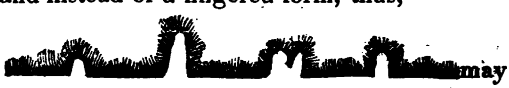
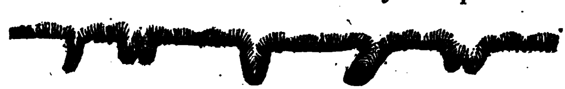
The vast *bed* of clay (as Professor Eaton would call it,) in which these deep creeks flow, is of considerable depth, and great extent, particularly eastward. It may be considered as beginning on the Genessee river, at the mouth of Black creek, and following up the valley of that sluggish

* Chert or horn-stone ?—Ed.

stream through the great Tonawanta or Oak Orchard swamp, and down the valley of Tonawanta creek. All Grand Island, and the small ones around it, are of this clay bed. It may be traced far west on the Chippewa, and over on the Grand river.

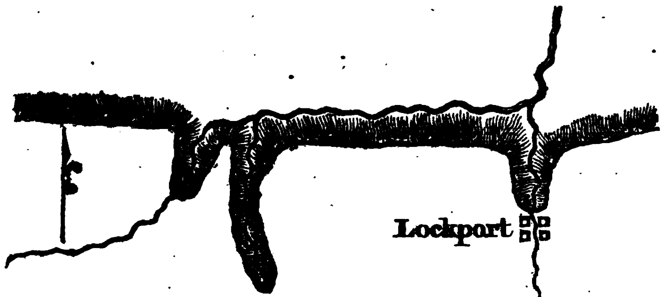
The lime stratum of Niagara Falls, with shells, is of very great extent, particularly eastward. Over it falls the Oak Orchard creek, Genessee river, Canandaigua outlet, Seneca outlet, and the streams from the lakes Owasco, Skaneateles, and Otisca, and it may be traced as far east as the falls of Skanado creek in Oneida county. The terminating edge of this lime stratum, is generally very straight, and varies but little from an east and west course. For the first 20 miles east of Niagara river, it ends in a denudated rock, projecting so much, that when tracing the level of the surface of lake Erie along the north side of it, in 1810, it was found a very convenient shelter from the showers.

Mr. William Smith and his followers, observe on the British strata, that in all the eastern parts of England, they "end successively towards the N. W., generally with a fin-"gered, or digitated outline, running out into ridges, be-"yond the general range of the edge or limit of the stra-"tum." The outline, or terminating edge, of this great lime stratum, which is such a distinguishing feature in the south side of the great Ontario valley, is towards the *north*, and instead of a fingered form, thus,

 may be represented thus : 

calling the side above the line, the terminating edge or ENDING, as Mr. Smith would term it. This formation, as has been mentioned, is more particularly to be observed between the Niagara river and the 18 mile creek. In almost all the indents or chasms that run back, south of the general range of termination, streams run from the level table-land above, and by wearing their respective chasms, have given them the appearance of being formed by the action of said streams. That all these ravines have been scooped out by the agency of the streams that occupy them, would be readily conjectured by every superficial observer, more particularly the one in which runs the Niagara river.

At the head springs of the 18 mile creek, it is shown to be otherwise. From 3 of these indents, the west branch of the 18 mile creek is formed as sketched below. *



Into the westernmost one a stream of water runs from the table-land above, and here is no bad miniature of the Niagara Falls, except that the solid lime rock, projecting far over the underlay of brittle slate, leaves more space behind the sheet of water. The middle one is the most remarkable. It cuts farther back beyond the general line of *ending*, and approaches nearest the Tonawanta creek—has no stream falling into the south end of it, but is to be seen as the valleys were "E'er moving spirit bade the waters flow."

The junction of these three streams was found to be more than 200 feet below the level of Lake Erie, cut down through the several strata of *lime*, *slate*, gray and red *sandstone*, all exposed to view in the precipitous sides of the chasm.

From these observations I have been led to conjecture, that the cataract of Niagara first began at the head of a deep indent, which reaches south to within 70 or 80 chains of where the falls now are. This length of 70 chains, forms the pool or basin into which the water is shot from the great pitch, and is much deeper than the falls are high. The head or south end of this chasm was probably once not as much below Erie level as the 18 mile creek *one* is, the rocky bottom over which the water now runs from this *basin*, being about on the same level with the 18 mile creek.

This capacious basin, into which the cataract pours, is something over 240 feet deep, and the surface of the bottom very uniform, all the way from the cascade to the north edge of the basin, (or as near said places as the persons sounding dare approach,) which bottom may be supposed to be a flooring of solid granite.

* West branch of the 18 mile creek.

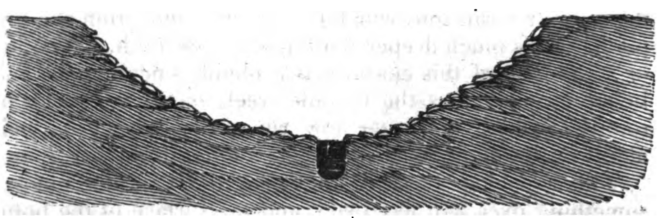
From the north side of this basin to their present place, I suppose the falls to have receded, worn by the action of the water and by frosts; and cannot believe that they began in the general line of *ending* of the great shell lime stratum near Lewiston.

In viewing the river from Lewiston upwards, the whole distance is very much of a similar character to within a mile of the falls: precipitous shores of rock, nearly parallel with each other, the water dashing over a rough bottom, with a descent generally of about 20 feet in a mile. A short distance at the whirlpool, is the only exception to the above features: here the river is deep, and two or three times the common width.

Owing to the easy disintegration of some of the rocks, the ravine is wider in some places than others. About a mile above the whirlpool, the ravine through which this vast body of water dashes along, is so narrow, that a man standing on the brink of the precipice on the American side, can throw a stone across the stream. If the falls were once at this place, why is no trace left behind? Or will it be said that a pool 240 feet deep was here, and that the rocks falling from the shores filled it up again? The narrowness of the chasm forbids this supposition.

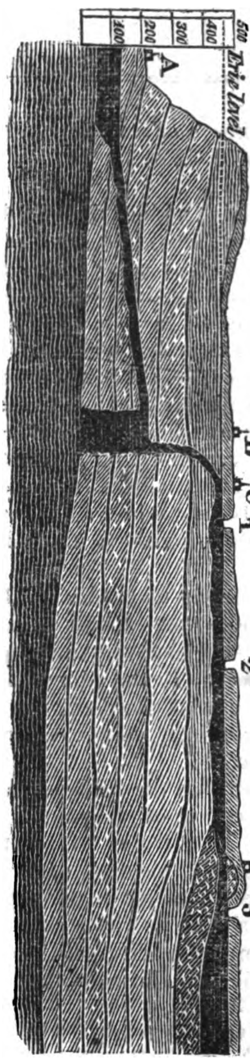
Immediately below the whirlpool, the ravine grows narrower as you descend towards the water, and here this mighty stream glides smoothly, though swiftly, through a channel of but little over 100 yards wide. The firm rocks which form either shore, are evidently still in place. The cataract, if it ever fell here, fell far and on a very narrow space.

A cross section of the chasm and stream here, would be something like this.



The smoothness of the rocks on each side would indicate, that while the channel was less deep than at present, the water flowed above them, and the surface of the stream was two or three times its present width.

Supposed section of the American shore, between Lake Erie and Lewiston.



A Lewiston.—B *Manchester.*—C *Schlosser.*—D *Black Rock.*—The deepest black, *A section of the water.*

1. *Cayuga Creek.*—2. *Tonawanta Cr.*—3. *Buffaloe Cr.*

This section, designed to give some idea of the strata on the American side of the Niagara, is nearly a copy of one sent to the late Professor Barton in 1813, and since returned to me by his Executor, the late Dr. Adam Seybert. I am pleased to see one so nearly the same, sketched by Professor Eaton.

South of the 12 mile creek valley, (down which it is designed to lead the Welland canal,) the great stratum of shell lime appears to have sunk to a level, we know not how low. By examinations made, it is ascertained, that at the depth of 8 feet lower than the level of the surface of the deep water above the falls, not a stone exists. The face of the rock may be as low as the bottom of the Chippewa, (here 40 feet deep) and the flow of the water through said canal, becoming unmanageable, we might see the destruction of the famed Niagara Falls, as the Fairhaven Falls, on the Poultney river, have been destroyed, by which operation a part of the state of New-York was thrown into Vermont. The naked rocks here remain, never more to be wet but by the droppings of Heaven. In one night, one man, it is said, set the stream to

remove, what millions could not again replace. The fine navigable Fairhaven bay, 9 miles in length, was turned into flats and shallows where no sloop can enter.—The fish were all killed by the feculent flood.

Art 3.—*On the pleasure and advantage of studying Natural History.* By Isaac Lea.

The study of Natural History has, within the last thirty years, engaged much more general attention than at any previous period. The object of this short essay is to endeavour to pourtray the advantages resulting from a knowledge of the works of nature, in order that we may more fully enjoy the richness of the field that lies extended before us.

Natural History may be said to entice while it instructs; and the student who once enters the portal, seldom wishes to return. Wandering from one fragrant flower to another, his appetite is never satiated, nor his thirst destroyed. Contemplating the endless variety and harmony of nature, he is enchanted, and pursues her with increased avidity. Saint Pierre has justly observed, that "Nature invites to the cultivation of herself."

In the animal kingdom alone, there exist upwards of 50,000* different subjects, and there are more than 30,000 different plants. The discovery of almost every new vegetable brings with it the knowledge of a new insect. In the mineral kingdom the compositions and forms are almost endless, the variety affording to the student a never-ceasing source of gratification to trace their peculiar characters.

It is a truth much to be regretted, that the study of nature is too much neglected in the usual course of education. The celebrated natural historian *Ray* says truly, "We content ourselves with a little skill in philology, history, or antiquity; and we neglect that which appears to me of greater moment: I mean the study of nature and the works of creation."

The writers of antiquity, in many instances, paid peculiar attention to this branch of learning. The observations of

* This is the number mentioned by some natural historians; but it is more than probable the number exceeds 100,000, when we consider the immense number of animalculæ, varying in almost every species of infusion, and that discoveries are daily making in all the branches of animated nature.

Herodotus on Egypt, the works of Aristotle, Theophrastus, Pliny, &c. give full evidence of its being held in high estimation during their times. But they had to struggle with difficulties, most of which have disappeared from the path of the student of the present day.

The study of the sciences seems first to have attracted attention in Egypt. There most of the early Grecian philosophers were votaries, and transferred the light of science to their own country. Her second change of residence was to Rome, from whence she reflected her light on most of modern Europe. At the same time, it is a matter of doubt whether India was not thebirth-place of all learning, and whether it was not carried from thence at a very early period into Egypt.

The invention of instruments, the great accumulation of knowledge, and the universal facilities for acquiring it, leave not an excuse for the man of education, who has not a partial knowledge of natural history. He has not half the enjoyment in objects which daily meet his view. When he looks on the splendid brilliancy of the diamond, he is unacquainted with its wonderful history, he knows not that it is pure carbon, little differing in composition from the common charcoal of his hearth; and that on the application of oxygen and caloric it disolves into gas, without leaving a vestige behind. He looks at you with astonishment and incredulity when you tell him an ounce of gold will gild a silver wire 1300 miles long—that it may be beaten into leaves so thin as not to exceed the $\frac{1}{300000}$ part of an inch. Of the beauty of the atomic theory he has never heard: he is ignorant of the wonderful class of animalculæ brought to our knowledge by the microscope.

To the manufacturer, a philosophic knowledge of the operation of his own business is peculiarly important; and yet how few would attempt to give an explanation of them! If the distiller be asked what causes his vinous fermentation, he could not inform you that it is the saccharine matter. The manufacturer of vinegar knows not that mucilage causes the acetous fermentation; and the manufacturer of ammonia is generally ignorant that gluten causes the putrefactive fermentation. In truth, manufacturers too seldom know the principles upon which their business is founded.

Many instances of the want of even a slight knowledge of natural history, among authors of great literary acquirements, could be adduced. Milton speaks of the "scaly rind" of the

whale. He might almost as well have said, the "scaly rind" of an eel, for they are both equally exempt from a squamose covering. Dr. Shaw also mentions, that "a modern writer, having occasion to allude to the dormant state of the butterfly and moth tribe, during their period of imperfection, has evidently shown that he supposed the animal to become a chrysalis, after having appeared in its complete or flying state, and has thus entirely inverted or reversed the real progress of the animal."

"Thus the gay moth, by sun and vernal gales
Called forth to wander o'er the dewy vales,
From flower to flower, from sweet to sweet will stray,
Till, tired and satiate with her food and play,—
Deep in the shade she builds her peaceful nest,
In loved seclusion pleased at length to rest:
There folds the wings that erst so widely bore,
Becomes a household nymph, and seeks to stray no more."

But if the poets of the day only were ignorant of natural history, we could have no great reason to complain. This, however, is not the case. The encyclopædists frequently fill up their pages with matter which would be disgraceful to the dark ages. The following extracts are from the Encyclopædia Perthensis, and in themselves fully illustrate the assertion: (art. Nat. Hist.) "As to the strata of the earth and mountains, the upper parts consist of rag-stone; the next slate; third, of marble, filled with petrifactions; the fourth again of slate; and lastly, the lowest of free-stone."

"It is generally agreed, that stones are not organic bodies, like plants and animals; and therefore it is clear they are not produced from an egg, like the tribes of the other kingdom."

"The misletoe always grows upon other trees, because the thrush, that eats the seeds of it, casts them forth with its dung."

These are absurdities, disgraceful to the learning of the present day, and are only equalled by the following account of the pelican:—"She brings water from afar, for herself and for her young; and she is furnished with an instrument well adapted to this purpose. She has a very large bag under her throat, which she fills with a quantity of water, sufficient for many days; and this she pours into the nest to refresh her young, and teach them to swim. The wild beasts, lions and tigers, come to this nest to quench their thirst, but do no hurt to the young."

It really requires not a little patience to quote such paragraphs, and I should have passed them unnoticed, but that they originate in high authority, and may lead to error. They prove the necessity of our acquiring information, to be able to judge for ourselves, and correct the false impressions made by ignorant pretenders in science. It is an old maxim, "buy truth and sell it not," and the poet Lucretius very happily says, "it is a pleasure incomparable for the mind of man, to be settled, landed, and fortified in the certainty of truth, and from thence to descry and behold the errors, perturbations, labours, and wanderings up and down of other men."

The investigation of nature cannot fail to be valuable. It engages all our intellectual faculties to the greatest extent, and by its ardent pursuit, the general stock of useful information is increased. The field for rational inquiry is extensive, and profitable beyond conception. The student drinks from the purest fountains with unceasing pleasure, and unallayed thirst. The longest life is insufficient to gather all the fruits that are within our reach.

When we reflect on the long chain that connects us with the most imperfect of animals, the infusoriæ, what a subject for contemplation is afforded to our astonished imaginations! Each link is worthy of peculiar attention, and yet, how neglected are they, comparatively! The vegetable and mineral kingdoms equally afford food for the contemplative mind, which sees in the simplest shrub, a perfect organization, furnishing all the means to make it a complete whole of its kind; in the formation of a single crystal, all its integrant moleculæ attracted and aggregated by their polarity into a regular mass, so mathematically correct as to surpass the possibility of being equalled by the hand of man.

Smellie says, "superficial men, or, what is the same thing, men who avoid the trouble of serious thinking, wonder at the design of producing certain insects and reptiles: but they do not consider that the annihilation of any one of these species, though some of them are inconvenient, and even noxious to man, would make a blank in nature, and prove destructive to other species which feed upon them. These, in their turn, would be the cause of destroying other species, and the system of destruction would gradually proceed, till

man himself would be extirpated, and leave this earth destitute of all animation."*

In the study of Natural History, systems should have the greatest attention. The celebrated Linnæus has done more for the world by forming systems for each branch of science, than any other Naturalist whatever, and his name will be connected with science as long as it has votaries. To him, however, have succeeded men of great learning, who by forming and arranging the various branches of Natural Science into their natural classes and orders, have caused knowledge to advance with giant strides towards a state of perfection. Among these stand pre-eminent Haüy, Jessieu, Breymont, Berzelius, Cuvier, Lamarck, Latrielle, Demarest, &c. each, and all of whom have made the world deeply indebted to them for their success—for industry and untiring perseverance in searching out the hidden beauties of nature.

It has been objected to the study of the sciences, that it takes the mind from things of more importance to our welfare; but this is an assertion more easily made than proved. Lord Bacon says, "No man need say that learning will expulse business; but rather it will keep and defend the possession of the mind against idleness and pleasure, which otherwise at unawares may enter, to the prejudice of both." Knowledge should lead us to value what we attain, and he who has no acquaintance with the sciences, but half enjoys that which daily meets his eyes. Goldsmith elegantly expresses this idea in the following quotation: "The mere uninformed spectator passes on in gloomy solitude; while the Naturalist, in every plant, in every insect, and in every pebble, finds something to entertain his curiosity and excite his speculation."

There are few persons who cannot spare some time to inform themselves on a part of Natural History. It is an immense store, presenting to us a never-ending variety of pleasing objects, and includes the whole Universe. Quadrupeds, birds, insects, fish, plants and minerals, present to the enquiring mind an endless source of the most delightful

* It may be said, and with great probability of truth, that Dr. Smellie has carried this calculation too far. In some of the islands of this globe, particularly in the South Seas, and also in New-Holland, there are many animals which exist no where else; and the observation may be true with regard to islands undiscovered: yet it cannot be supposed for a moment, that if those countries should sink into the ocean, and all their animated inhabitants be annihilated, we should suffer in the slightest degree from their total destruction.

study. To scrutinize the first cause is in vain; we must make ourselves acquainted with the effects and compare them. —In this we have ample room to engage all our faculties. The celebrated Dr. Priestly, in one of his lectures, makes the following observations on this subject:—" Of scientific pursuits, the most liberal, the most honourable, the happiest, and what probably will be the most successful employment, for a man in easy circumstances, is the study of nature; and therefore, to this important object, a principal attention should be given in educating youth, who have the means of applying to these instructive and comfortable pursuits. Every man finds vacant hours from his ordinary business, which cannot be better filled than by such attention as leads to the improvement of the understanding, and elevates his mind to admire more and more the astonishing works of the Creator." If we examine into the physiology of animated nature, we find every animal, however minute, so wonderfully formed as to excite, at every step, our astonishment and admiration: if we watch their habits, we find so much intellect, so much calculation and foresight, as almost, in some instances, to humble our own nature. The sagacity of the Elephant, which in the eastern world is taught so many and such wonderful lessons, and the almost human ingenuity of the beaver in our wildest forests, are almost surpassed by the smallest animalculæ or polypi. What are our reflections when we see the industrious architect of the many islands of the Indian archipelago, daily raising *perpendicular* walls on the windward side, some hundred fathoms from the bottom, while on the leeward side they are formed in a promiscuous manner! In this we see a degree of intelligence almost beyond crediblity. By this formation, the young are protected from the storms and washing of the waves, and repose in a state of security and prosperity. How interesting, to contemplate an act of precaution in an animal so simply formed as to be taken for a species of vegetable, until within a few years! It may be called instinct: by any name it is wonderful and interesting.

The arts and sciences originated in the want and necessities of society, and a knowledge of Natural History, has conduced materially to the civilization of mankind. What would be the present state of society, if we were unacquainted with the properties of one metal, iron? Where would be our telescopes, our mariners' compass, our chronometers, and a thou-

sand other instruments, all of which have contributed their portion to the advancement of civilization. By bringing to his aid the powers of the horse, the camel, the elephant, &c. man has greatly added to his own comfort. These make up a few important links of an immense chain, which binds us together, each one performing its own duties, and administering more or less to our wants and pleasures.

In conclusion, I feel that I may safely say, the study of Natural History, with regard to its importance, is not surpassed by any of the abstract sciences. Each has its advocates, and most persons find the advantage of bringing the aid of sister sciences to that which is their peculiar favourite.

Art 4.—*Facts and Remarks relating to the Climate, Diseases, Geology and Organized Remains of parts of the State of Ohio, &c.* By Caleb Atwater, of Circleville.

(Communicated for this Journal.)

1. Climate.

It is known to you that Ohio* is wholly a secondary, or alluvial country. From the very nature of all secondary countries, there must be large tracts of alluvion. The streams have few rapids in them, are not very straight in their courses, are apt to overflow their banks, run slowly, and are apt to fail in the summer and autumnal months. The Botany of such countries is rich, like the soil which produces it—the water not very pure, and the air, at particular seasons, bad. To a Geologist, the reasons why these things are so, are plain.

* I formerly took considerable pains to collect facts to illustrate the Geology and Mineralogy of Ohio, with the hope, that sufficient patronage might be obtained, to enable me to publish an essay on these interesting subjects. Not having, however, obtained that patronage, I may occasionally communicate to you, for the American Journal of Science, some of my information; though I wish not to attempt a methodical treatise, but rather to throw out some remarks on particular localities and subjects, in order to excite others to undertake a more thorough investigation than my occupations permit me to make.

I have paid considerable attention too, to our climate, which in all countries has such a decided influence on the character, health and happiness of the people, living within its operation.

I propose in this paper, to say something concerning our climate, hoping that my remarks may elicit more valuable communications from some abler pen.

It will be recollected by those who read your Journal, that in my paper on the "Winds of the West," in vol. 1. p. 276, I ventured to predict, that as the country became more cultivated, our diseases would be fewer in number and more acute, and I regret to state that my prediction has been fulfilled to a remarkable degree. Pleurisies, pneumonia typhoides and pulmonary complaints, prevail more and more every year, in those parts of the state with which I am personally acquainted. These complaints were unknown here, until within the last ten years. Liver complaints are, however, so common here, that almost every individual is more or less affected in that way during some part of the year.

As I have travelled over a considerable territory, in the practice of the law, I have noticed a fact, which I do not recollect to have seen mentioned by any author.—Every summer and autumn, particular tracts of country, sometimes large and sometimes small, begin, just before sunset, to emit, from the surface of the earth, a mist, which continues to rise until it becomes quite dense, and is not dispelled until the heat of the sun chases it away on the ensuing morning. Its smell is extremely nauseous, and it produces, after a few days, agues and fevers. This mist rises from alluvial soil, along our streams, and in our prairies, and the warmer the day, and the shorter the grass, and the less the vegetation, so much the worse. So sure an index of ill health is this mist, that I am able, from its presence or absence, during the months of August, September and October, in any region which I visit in the southern part of the state, to ascertain the health of the inhabitants, whether good or bad. As the country becomes more and more improved and cultivated, if these miasmata should prevail more and more, the valley of the Mississippi may be depopulated. The fog arising from running waters, compared with this deleterious mist, is harmless, because, where a person is exposed to it, and puts on woollen garments as a protection against the dampness of the atmosphere, no injury is sustained. By keeping within doors as much as possible, when this mist loads the air with its poisonous qualities, by maintaining a good fire in the room, and by taking peruvian bark, and pearl ashes and vinegar, this enemy to life and health, may be baffled.

I have said that the mist *usually* ascends from alluvion, but in some years it is formed almost wholly in the hilly parts of this region. Thus it happens, that in some seasons the sickness is confined to towns situated on the banks of rivers, and in our prairies; whereas in other years, these places are very healthy, and the sickness is confined to hilly regions. There has been a remarkable uniformity in these instances, and natural causes frequently operate on a large scale, much larger, many times, than we seem willing to admit.

I forgot to say in its appropriate place, that whenever standing water, during our warm weather, is covered over with a *green scum*, it sends forth a fog at night, which produces sickness, as far as its influence is felt; and the erection of mill dams in the immediate vicinity of nearly all our towns, has proved extremely prejudicial to health. Columbus, for instance, was a healthy place, until ponds of stagnant water made it sickly during summer and autumn. What effect our canal, running three hundred and six miles in its whole length through a rich alluvial soil, may have upon the thickest settled part of the state, as to the health of our inhabitants, time alone can determine. It always appeared to me to be desirable, that the water in it should have a trifling descent, say half an inch in a mile, so that, as in China, there might be a gentle current of the water in the canal, which would prevent stagnation. As this grand work is to be completed in the autumn of 1829, its effects on our health will soon be known.

2. Atmospheric Phenomenon.

Before a storm here, I have often noticed, in an evening of the latter part of autumn, and sometimes in the winter, a phenomenon not recollected by me to have been seen on the east side of the Alleghanies: Some one spot or spots near the horizon, in a cloudy night, appeared so lighted up, that the common people believed there was some great fire in the direction from which the light came. I have seen at once, two or three of these luminous spots, not far from each other; generally there is but one, and a storm invariably proceeding from the same point near the horizon, succeeds in a few hours.

3. Reliquiæ Diluvianæ.

These are so numerous in this state, that it will not be expected that I should do more in this article, than mention a few of them, and the places where they are found. If one tree furnished Mr. Schoolcraft matter for an interesting and valuable memoir, how shall I condense my remarks, so as even to refer to the great number of similar facts existing in Ohio? In the vicinity of the Ohio river, in the counties of Washington, Meigs, Gallia and Lawrence, and on the waters of the Muskingum, in Muskingum and Perry counties, I have carefully examined not a few of the fossil trees, there existing. Among them I noticed the following, (viz:)—Black oak, black walnut, sycamore or button wood, white birch, sugar maple (acer saccharinum,) the date tree or bread fruit tree, cocoanut bearing palm, the bamboo, the dog wood, and I have in my possession, the perfect impression of the cassia and the tea leaf! Of ferns I have beautiful impressions of the leaves, and of the bread fruit tree, flowers, fully expanded, fresh and entire! I have specimens so perfect, and so faithful to nature, as to dispel all doubts as to what they once were. The larger trees are found mostly in sandstone, although the bark of the date tree, much flattened, I ought to say perfectly so, is found in shale, covering coal. I am aware that a mere catalogue of fossil trees, shrubs and plants, is not very interesting—that the Geologist wishes to know among many particulars, in what formation they exist, and the exact spot where they are found. I am in possession of all the particulars. Every stratum from the surface downwards, has been carefully measured, in some places, to the depth of 400 feet, and I have correct diagrams.* The date is a large tree, not very tall, and having numerous and wide spreading branches. Nine miles west of Zanesville, lying on the brink of Jonathan's creek, and near the road leading to Somerset, Lancaster and Circleville, the body of a bread fruit tree, now turned to sandstone, may be seen. It is exactly such sandstone as M. Brongniart found the tropical plants imbedded in, in France, mentioned in a former number of this Journal. It contains a considerable quantity of mica in its composition. The cassia was found in such sandstone, in the Zanesville canal. The bamboo is mostly impressed

* I have not the leisure to copy these now, and I may want them in a larger work, at some future day.

upon iron stone, at Zanesville; especially the roots, and the trunk and leaves, are found in micaceous sandstone. The iron stone is sometimes, apparently made of bamboo leaves, the leaves of fern and bamboo roots. It happens frequently, that the trunks of small trees and plants are flattened by pressure, and the bark of them partially turned into fossil coal. Thus the shale oftener contains a *bark*, now become fossil *coal*, and a stratum of shale in succession, alternately, for several inches in thickness.

Before I leave Zanesville, I wish to make a passing remark or two, on the subject of finding the fossil remains of tropical plants here. The date, the bamboo, the cocoanut bearing palm, the cassia, the tea plant, &c. are found at this day only in tropical regions, or in a climate where there is very little frost. At Zanesville, so severe is the winter at present, that the mercury sinks several degrees below zero.

Two questions naturally present themselves to the mind— has our climate become colder than formerly? or have the tropical plants changed their nature? It is known that several tropical plants have by degrees been removed, farther and farther to the north, and at length became naturalized to a northern climate. I refer particularly to the palma christi. But where is the plant which has been driven from our latitude to Cuba? I know of none. Has the climate of the world generally become colder, then? I say generally, for some countries probably have. Some writers suppose that the climate of England has changed in this manner. We have good evidence that during eighteen hundred years past, the climate of Rome and Palestine has undergone a great change, as the writings of Horace, Virgil and others of the Augustan age, clearly evince:

> " Vides, ut altâ stet nive candidum
> " Soracte; nec jam sustineant onus
> " Silvae laborantes; geluque,
> " Flumina, constiterint acuto?
> " Dissolve frigus, ligna super foco
> " Large reponens.—

What a picture of the winter which prevailed at Rome in the Augustan age? Such a picture would now best suit the meridian of Quebec. In other passages of the same author, we learn that the snow was so deep near Rome, that the deer pushed it aside by their breasts, as they were pursued by the dogs. Who now sees the roofs of houses at Rome, or even in Paris, ready to break down with snow? In David's

time there was snow in Palestine, and allusions to frost: snow and hail are frequent in the Psalms and in the writings of the prophets. The inhabitants of Palestine are no longer in the habit of attacking lions in their dens "on a snowy day," for no such days now exist in that country. But Italy and Gaul and Germany, and indeed all Europe are no more what they were in the days of David, of Horace and Virgil. Those vast forests, which formerly generated so much moisture, cold weather, snow, hail and rain, are swept away by the hand of man, and the climate is meliorated. But no such cause has operated here, and the fact being ascertained, that tropical plants and animals once existed all over the world, clearly proves that a tropical climate was once equally extensive.

The supposition that these tropical plants were transported northward by the ocean, unfortunately for such an opinion, is disproved by the fact that some of these trees, or rather roots and a part of their trunks, stand upright* evidently on the spot where they grew, and others, with every root entire, lie to appearance exactly where they fell when turned up by the roots. Again, if floated from tropical regions, how happens it that their flowers were uninjured?—These show all their original beauty of form; they are fully expanded, and could not have been transported from any considerable distance. Scarcely a day could have intervenen between the period in which they were in full bloom, and that in which, by that catastrophe which long since overwhelmed our globe, they were "*embalmed*" in the spot where they are now found.

4. Primitive Rocks in Ohio.

Bordering on the Ohio river, in the state of Ohio, is a hilly region, which covers, perhaps, one third part of the surface of the state. Above these hills, towards Lake Erie, primitive rocks are found, such as granite, gneiss, mica slate, with imbedded garnets, &c. It is often asked, how these rocks came here? and from whence were they conveyed?

That they are out of place, in a region decidedly secondary and alluvial, no one can doubt. They are water-worn, rounded and smoothed—exactly like the pebbles in our

* These are found in coal beds, although not near Zanesville. If hereafter I find leisure to describe our coal fields, they will be noticed.

our alluvial soils, and like them they have been abraded by the stones with which they have come in contact, aided by the waters in which they have been immersed. That they have been brought hither from the north, north-west and north-east, appears from the following considerations:—1. They exactly resemble the primitive rocks found, in several instances, on the shores of Lake Superior, and on the north side of Lake Ontario. 2. As we proceed northwardly from the hilly region above mentioned, they increase both in number and size. I have seen several of them on the northern side of the hilly region about Hillsborough, in Highland county, but I never saw any on the southern side of this region, except in the form of pebbles, in the beds of rivers passing through the country where the larger masses exist. These rocks abound most in vallies, which now are, or appear to have been the beds of streams. Thus in the bed of the Whetstone, below the town of Delaware, large rocks of this class are seen reposing on limestone. The latter rock is *in situ*, and abounds in shells. The stream (the Whetstone) has worn itself a channel, in some places very deep, through clay slate, until it has been checked in its progress downwards by a very hard, compact limestone. In the barriers (improperly so called) in Madison county, none but primitive rocks are found, and they are used for chimneys, and for the underpinnings of buildings. They are sometimes used for mill stones, and one fragment was so large as make three mill stones. But by what means were they conveyed to the spot where they now are? Water was undoubtedly the agent. Some persons have supposed that volcanoes have thrown them upon large bodies of floating ice; and the theorist has, in order to support this view, only to cover the valley of the Mississippi, and, indeed, the American continent with water, and then to form a current in the ocean from north to south, or from the north-east to south-west. But it is unphilosophical to look for more causes than are necessary. Readers acquainted with the voyages of polar navigators, need not to be told that the icebergs sometimes adhere to the rocks at the bottom of the sea, and that great winds and powerful waves break up these icebergs; to the lower surface of which, rocks adhere, and that they are thus transported, until, by the dissolution of the icebergs, they are precipitated to the bottom of the sea, wherever they may happen at the moment to be. Indeed, we see the same thing annually happen on a small

scale, on the breaking up of the ice, where it adheres to the beds of the streams. That the valley of the Mississippi was deposited by water, and that it is one vast cemetery of the beings of ages past, is proved by almost every rock found in this region. Primitive rocks are found in Indiana and Illinois, north of their hilly region, as in Ohio, south of Lake Ontario. They are also found in the state of New-York, in a country geologically similar in all important respects to Ohio, Indiana and Illinois.

ART. V.—*Notes on certain parts of the State of Ohio, by* DR. S. P. HILDRETH, *of Marietta, in answer to queries by* CALEB ATWATER, Esq.

(Continued from Vol. X. p. 331.)

"NATURAL history of plants; whether noxious or useful, native or naturalized"?

In answer to this inquiry, I can do no better than to refer you to Doctor Drake's "Picture of Cincinnati," where you will find the most, if not all the plants of a medicinal nature that are to be found in this county. Among the flowering shrubs not mentioned by him, we have two species of kalmia, or laurel; one of them bearing a most beautiful flower. It is found on the north sides of hills, amidst rocks and precipices. The draconitum fœtidum, or skunk cabbage, is also a native of this county. It is said to be a valuable medicine in nervous diseases.

"Climate, meteorological observations, births, deaths, marriages, epidemic maladies, diseases among men and animals, crimes, suicides."

The climate in this county does not differ materially from that of the rest of the state bordering on the Ohio. Vegetation is about a week earlier on the banks of the Ohio, than it is at the distance of 20 miles from the river, either north or south, but more especially to the north. This difference is attributed to the influence of the southerly winds, which blow more regularly from that quarter immediately on the river, than they do at any considerable distance from it. The year 1818 has been productive of as great extremes in heat and cold and other meteorological phenomena, as any other year since the first settlement of the state. On the

3d of February, 1818, it commenced snowing in the night, and continued all that day, until 8 or 9 o'clock in the evening, probably about eighteen hours. On the morning of the 4th, I measured the snow, and found it twenty-six inches, or more, on an average. The wind was moderate, and from the north-east and east. The snow was but little drifted, and lay very evenly over the face of the earth. The 2d of February was pleasant and moderate. This was considered the deepest snow, by ten or twelve inches, that has fallen since the first settlement of the country. February 8th, snow in the morning, with high wind from the north-west, and very cold.

February 9th, at 7, A. M. Farenheit's thermometer sunk to 20° below zero. On the 10th, at half past 6, A. M. it was down to 22° below zero, in the open air, and suspended to the limb of a tree. With all this severity of cold, the Ohio river was not frozen across; it was full of floating ice, and during the night and morning of the 9th and 10th, threw up a continual cloud of vapour, which darkened the air; and freezing as it ascended, fell again in a moderate shower of snow. So intense was the cold, that there was a continual cracking and snapping, by the contraction of wood in buildings and in trees. Very strong brandy, exposed in a tea-saucer to the open air, through the night of the 9th Feb. was found frozen to ice the next morning. Peach trees, sassafras, and spice-bush, were either killed or materially injured, generally, throughout this county. In many instances the dogwood, or cornus florida, was killed. The weather was colder at this time, by 10 or 12 degrees, than has been known since the country was first inhabited.

In Barton's Medical and Physical Journal, vol. 1st, page 143, I find that at Gnadenbutten, on the Muskingum, the thermometer sunk to 15° below cypher, on the 19th December, 1804, and also on the 21st January, 1805. But this place is considerably further north than Marietta, and the winters are generally several degrees colder.

On the 23d of May, 1818, the thermometer, at 2, P. M. was up to 98° in the shade, and to 124° in the open sun. On the 11th and 12th of July following, it stood at 99° in the shade, and at 138° in the sun. The extremes of heat and cold in this year, were as great as are usually known in the United States, amounting to 121°.

Our epidemic disorders are those common to the eastern and middle states. The measles, whooping cough, and influenza, occasionally visit us. The whooping cough has been wandering through different parts of this county and the counties adjoining, for these three years past, and has not wholly left us yet. When children have been ill about two weeks with this disorder, it has been found that *vaccination* very materially lightens and shortens its effects. I have known it to have this result, in several instances, on children under my care.

The influenza has not been general through the country since the year 1807. At that time it overspread the United States. The summer and autumn of 1807 were unusually sickly, through that part of the county bordering on the Ohio; and not only in this county, but generally so through the whole extent of the river. The settlements distant from the large streams were as healthy as usual. The season was unusually wet, and the repeated rise and fall of the Ohio, and tributary streams, in the heat of summer, leaving great quantities of mud and putrefying vegetable substances, to generate noxious effluvia, was, without doubt, the cause of the sickness. The disease was a bilious remitting fever; in some instances nearly approaching to the yellow-fever. About forty died with this fever in Marietta. In the country above and below Marietta it was not so fatal. This place seems to have been the focus of its virulence. Since that time, this town, and the county generally, has been healthy. In March and April, 1816, the peripneumonia typhoides, or, as it was usually called, the '*cold plague*,' prevailed in the northern part of this county, in the settlements on Duck creek. It was very mortal in its commencement, but grew more mild as the spring advanced. It was was also very violent and fatal in Roxbury township, on the Muskingum river; about thirty dying with the disease in that small settlement. In Marietta, only one or two cases came within my knowledge. Our disorders are mostly of that class usually denominated bilious, which is probably the reason that consumptions are not more frequent amongst us. Of those who die of diseases in this place, not more than one in forty is carried off by consumption. Our fevers, for the last four or five years, are mostly of the typhoid type, inclining a little to inflammatory in the winter, and more purely typhus in the summer. The disorders most common

to children, are "cholera" in the summer, and "croup" in the winter.

Our sheep are subject to bowel complaints of several kinds, mostly of a putrid nature. These disorders are usually produced by improper diet, and by sleeping on wet ground with their fleeces full of rain water. This latter cause also produces violent coughs, and sometimes real consumptions. The best preventatives for these disorders are, furnishing them dry and airy lodgings, and giving wood ashes and tar mixed with their salt.

Our horned cattle are subject to the bloody murrain, to obstructions in the viscera and bowels, like colic; to the "*hollow horn,*" and to poison from eating "buck eye" and laurel. Our cows, that drop their calves after the warm weather commences, are particularly subject to bloody murrain. The best and almost certain remedy for this disorder, is giving them freely of alkalies. Pearlash, or the lye of wood ashes, diluted with water and mixed with their food, or poured down their throats with a bottle, has been known to effect a cure after the animal was so much reduced as to be unable to stand. The cattle themselves, even where they have plenty of salt, are fond of licking the ashes which are left after burning log heaps and brush, thereby indicating that alkalies are necessary to the preservation of their health, or for preventing diseases. So well convinced of this are some of our farmers, that they are in the habit of mixing the salt for their cattle with an equal quantity of good clean ashes. They soon become fond of it, and lick it up as readily as they would clear salt.

In the summer and autumn of the year 1813, a number of cattle in this county were attacked with a disease, which, so far as I have been able to learn, was entirely new. The disorder first commenced with an inclination to frequently lick or rub some part of the body. This was generally about the right or left nostril, or some part of the head between the horns and the angle of the mouth. In the course of a few hours this desire of rubbing the affected part increased to an astonishing degree. They would continue to rub themselves, as long as they could stand, until the hair and skin would be torn off, and the side of the head and neck covered with blood; and after they were so much exhausted as to be unable to stand, they would continue to rub, until the earth was torn up in a circle around them, and on-

ly stopped with the extinction of life. The rubbing seemed to increase their distress, and make them bellow as if distracted with agony. The side of the head and neck was considerably swelled, but no other mark of disease could be discovered in the bodies of several which I examined. The blood drawn was very dark, and the skin, in the course of the disease, colder than in health. Trepaning, bleeding, cathartics, and various other remedies were tried, but all failed. Stramonium and opium were also used, as most of them were affected with spasms, or convulsive twitchings, in the muscles of the neck and side. Death generally put an end to their distress, in the course of twenty-four or thirty-six hours. The disease has not appeared since that year; but had a belief in witchcraft been common in these days, some poor old woman would undoubtedly have been charged as the author of the calamity!

Crimes of a very heinous nature are not common amongst us; they mostly belong to the classes of petty larceny, assault and battery, &c. &c. Suicide is a very rare occurrence; I do not recollect more than one or two instances of the kind, in the last twelve years.

"The state of the learned professions, of morals, of religion and learning; the number of academies, common schools and colleges, how supported, and the mode of instruction?"

Considerable attention is paid to learning in this town and county. Some of the towns support schools nearly or quite all the year; and all of them have schools through the winter months. There are few children of a proper age, who cannot both read and write. In the township of Marietta, for several years past, we have had two schools through the year, and as many as six or eight in the winter. One of the annual schools has been a regular academy, in which were taught the dead languages, geography and the use of the globes, rhetoric, oratory, &c. &c. In the other were taught geography, English grammar, arithmetic, &c. These schools are generally supported by subscription; the subscribers paying from two to five dollars per quarter for each scholar, in proportion to the branches taught. The school sections, No. 16, afford some assistance. The rent of the section in Marietta, at its present valuation, affords about $600 per year. It has heretofore been from two to three hundred a year.

We have at present three lawyers, four physicians, and two preachers of the gospel—one a presbyterian, and the other a methodist. There are several religious societies which draw a proportion of the rent of section 29, on which the town of Marietta is principally situated; but there are only two which support regular teachers of the gospel. The rent of this section amounts to near $600 per annum; and is divided amongst the religious societies in proportion to their numbers. Under a statute of the state, several of the societies have heretofore appropriated their portion of the rents to building meeting houses; and of late, one society, denominated the universalian, has devoted its funds to the purchase of a library on moral and religious subjects.

The state of morals has much improved in the course of a few years. To assist in the support of religion and morality, we have several useful societies. Amongst these we have a "Bible Society," a "Society for the promotion of good Morals," a "Tract Society," a "Female Friendly Society for the promotion of Religion and Charity," and a "Female Society for assisting the spreading of the Gospel amongst the American Indians." We have also an "Emigrant Society," for the assistance of poor emigrants. The members of the "Moral Society" are the guardians, and were the first movers of the Sunday Schools, which have been established in this place since 1816 and 1817.

"The state and number of the population at different periods—the religious persuasions—the number of houses?"

The township of Marietta has so frequently, within a few years, been divided and subdivided, that it would be difficult to give the population in years past, with much accuracy. The present population is about 1500. The religious persuasions, are Presbyterians, Methodists, Baptists, Universalians, and Halcyons—though this latter persuasion has gone out of repute within a few years. It is about 12 years since they commenced amongst us. Their first leader was a preacher by the name of ———; but a female teacher soon took the lead and introduced some new tenets. For two or three years they became considerably numerous in this country, and several preachers sprung up among them. Their principal articles of faith were, that any one could obtain life and immortality who would strive therefor; and that the souls of those who did not thus strive and desire, were at death annihilated; or that death to them was eternal sleep. They

refrained from eating any kind of flesh, and held that marriage was sinful. They also believed that by practicing this kind of pure life, they could at last become so perfect, as to live without food; that they would not be subject to diseases or death, could work miracles, and finally raise the dead. So strong was the belief of some of them in this doctrine, that one young man also lately died of debility, induced by putting in practice that article of their creed, which taught that man by faith and practice might learn to live without food, and thus become immortal. After his death, he was kept three or four days, in the belief that he was only in a trance, and that on the third day he would awake from his sleep, and arise a pure and perfect creature. This sect was not confined to Marietta, but they had adherents in the upper part of this county, on the Ohio river, and also in some of the adjoining counties. It was 30 or 40 miles from Marietta, where the young man made the experiment.

"Antiquities, whether belonging to the Indians, those who erected our old forts, or to the French?"

The antiquities in this county, as far as I am acquainted, all belong to that ancient race of men, whose memory has perished from the face of the earth. You will have a description of those in this neighbourhood in a short time, from Mr. B. Putnam.* About 20 years since, there was found on the sand bar, in the mouth of the Muskingum, a block of lead of several pounds weight, with an inscription on it in French, indicating that possession was taken of the country in the name of one of the kings of France—but whether it was Lewis XV. or XVI. I was not able to learn, nor the date of the inscription. It was destroyed several years since, and the lead melted into balls.

Fort Harmar stood on the west side of the Muskingum, at the mouth of the river.—But no remains of the fort are now standing, and a considerable part of the ground which it occupied has tumbled into the river, and been washed away.

"Meteors, comets, eclipses, earthqnakes, tornadoes, tempests, freshets, inundations, volcanic eruptions, extremes of heat and cold, or other remarkable events?"

No remarkable meteors have been noticed lately; but a very large and brilliant one was seen a few years ago, and it

* See the first Vol. of the Archælogia Americana for a full account of these antiquities.—Ed.

must nudoubtedly have produced a shower of meteoric stones. The comet and earthquakes of 1811, were seen and felt at Marietta at the same times, or nearly so, as they were at Cincinnati, as mentioned by Dr. Drake in his book of notices. That tremendous and extensive tornado, which visited this country on the 28th May, 1809, commenced at Marietta, at 4 o'clock P. M., just as the inhabitants were leaving church. It came directly from the west, but was attended with veins and currents, varying more or less from the general course. It blew down a number of buildings, and injured several others in their roofs and chimneys: but the greatest damage was done to the forests. In many places where the veins of wind were strongest, scarcely a tree was left standing for a great many rods in width, and for a half mile or a mile in length; according as the ridges and hills gave direction to the wind—a copious shower of rain with some hail, attended the storm. As near as I can recollect, the strength of the hurricane was past in about fifteen or twenty minutes.

ART. VI.—*A Review of the Principia of Newton.*

RETROSPECTIVE reviews of works which long since have passed the ordeal of public opinion, may appear useless and unnecessary. If the character only of such works were the object of the review, and that had been established by the grand tribunal of the public, the individual sentiment of a critic or a reviewer, would be of small amount; it would be only as a drop, whatever its nature or quality might be, which must be amalgamated with, or lost in the ocean into which it falls. But though the character of a work be a principal object in reviewing it, especially if it be new, our opinions cannot rationally rest on the assertions, predilections, or fancies of a critic. General praise or censure is *vox et præterea nihil*, as to all the purposes of mental illumination; we want specifications by abundant extracts, which may exemplify the substance and manner of the author; and a complete analysis of the parts of any great work is necessary, if we would form a correct judgment of the beauty and perfection of the whole. Considered in this point of view, reviews,

whether of old or new works, may be made the instruments of conveying knowledge to the less informed, on subjects to which they have no access, or which, in the works themselves, would be above their comprehension. There is, moreover, a particular advantage resulting from an analysis of old standard works, which consists in comparing the inventions and discoveries of our progenitors with those which plagiaries and pretenders have obtruded on the present generation, as their own. It is basely iniquitous and unjust, that men should shine by the reflected light of others in past times, relying for security on the general ignorance of what has been done in former ages. In the present advanced state of the sciences, one must be possessed of great learning to be able to detect all the sources of plagiarism : but on particular subjects, to which he has devoted his principal energies, it may reasonably be supposed that he is competent to such an undertaking: at any rate, discussion will elicit truth, the only object which a truly scientific man has in view. With such impressions, I enter with diffidence on the task of reviewing that, which acknowledgedly is the most stupendous production of the human mind, which ever has appeared on earth, viz. the Principia of Newton.

It is generally known, that before the time of Lord Bacon, even from the remotest period, little or no improvements had been made in Natural Philosophy, the cause of which is not attributable to the want of ardour in the ancients for that science, who, it is believed, in that particular far surpassed the moderns; but to an erroneous *system* of philosophizing, established by Aristotle, and the Platonic School, which consisted in deriving physical principles, as they had those of the mathematics, merely from intellectual relations. They did not consider, that those of the latter science were eternal and immutable in their nature, and necessarily connected with the ultimate resort of truth in the human mind, and that the others were contingent, and dependent only on an order of things externally existing, and unconnected directly with the intellectual relations of the understanding. This system, however, of mental physics maintained by the authority of names, held possession of the schools for nearly 2000 years, until the time of the above mentioned celebrated reformer. The genius of this great man first dared to break the shackles, which the authority of names and antiquity had imposed on the world. He clearly perceived that the operative prin-

ciples of nature were secrets contained in her own bosom, and could not be discovered by the human intellect but by diligent research; in short that the true principles of Natural Philosophy can be found only by experiments, and observation of what really exists in the natural world; that the high flights of the ancients in the assumption of general principles unsupported by facts, and in synthetical deductions from them, ought to be discarded; and that natural science could not be improved, or advanced but by the contrary method of analysis, which proceeds from particular to general conclusions by induction. When the general principles have been well established so as to bear the test of the *experimentum crucis*, or so as to be explicable only in one way, we may safely proceed to synthetical deductions. This new mode of philosophizing, received the applause and approbation of all the learned, who were not chained to prejudice, or infatuated by idolatrous reverence for the names of Aristotle, Descartes, and others. An adherence to the Baconian method by succeeding philosophers, has in a short time produced more wonderful discoveries, than had ever before been made, or probably ever could be made by the ancient methods of philosophizing. But that, which has afforded to the author of the new system the greatest celebrity, and which has unfolded more profound principles, and recondite operations of nature in her great works, is the production of the great genius now before us. It was one of the first, and incomparably the greatest exemplifications of the excellency of the Baconian system. It is said by a writer in the Edinburgh Encyclopedia, under the article Logic, that Newton is the follower of Kepler and Galileo, not the disciple of Bacon. In mathematics, it is true, Newton followed, not copied, or imitated those mathematicians: but in philosophy, he followed strictly the Baconian system, as will be evident to all, who consider the plan of the immortal work now before us.

The general outline of the work consists, first, in an analysis, by the most profound mathematical investigations of the forces, and their laws necessary to produce certain movements of bodies, under almost every circumstance and condition, and the converse of this, viz. the nature and laws of the force being given, to investigate the movements of bodies under the influence of one or more forces. To *force* of one kind or other, and the general effect of its motion,

are attributable almost all the phenomena of nature, and particularly those of the heavenly bodies. Secondly, whenever investigations relative to the nature and laws of any force, are found to apply to the objects of the natural world, in numerous particulars, so as to bear the test of an *experimentum crucis*, his analysis in respect to it ceases, and the author then safely assumes the contrary order of synthesis. This is precisely the manner in which our illustrious philosopher has conducted his celebrated work, in strict coincidence with the Baconian logic by induction. Wherein then consists the justice of the Encyclopediast's remark? But agreeably to our plan we will endeavour to exhibit the parts of this stupendous production of inventive genius.

It commences with what in a regular work on such topics, would always be useful if not necessary, viz :—The general and fundamental properties of bodies at rest or in motion. The next subject is the laws of motion, and the consequences of those laws as resulting from operative forces in different directions. One of these first principles, the continuation of motion, had been attempted to be established by *a priori* deductions from the immutability of the Deity*; this was the very course of philosophy which Bacon condemns as arrogant, and beyond the capacity of any created being. Newton on the other hand, grounds his laws on facts and experience, and from them has very concisely deduced all the principles of the mechanical powers, so much and so uselessly diffused by modern writers.

The next preliminary propositions are those which relate to prime and ultimate ratios, intended as the *metaphysique* or foundation of the sublime and intricate investigations of the subsequent parts, or body of the work. But before we enter on those investigations, which are principally mathematical, it may be necessary to observe, that Newton in delivering their results, has proceeded in what is called in mathematics, the synthetical mode of demonstration. As to the mathematical form of deriving particular and isolated truths, which constitute the philosophical or logical analysis, by induction, it is wholly immaterial, for mathematical analysis and synthesis differ in nothing except that in one case, the

* "Atque ex eadem immutabilitate Dei, regulæ quædam, sive leges naturæ cognosci possunt, quæ sunt causæ secundariæ, ac particulares diversorum motuum, quos in singulis corporibus advertimus." He then goes on to enumerate some of the laws of motion, and particularly that of the continuation of motion.—*Des Cartes' Philosophy.*

proposition is made a problem and the other a theorem.* Newton, however, has been censured for concealing the means he employed in the investigation of his difficult problems, which in the opinion of a great mathematician, must have embraced all the artifices and refinements of the modern analytics. In reply to this, it may be observed, that the exqnisite workmanship of a great artist, does not necessarily imply the possession of superior tools, or that his own genius could not supply the want of them, or of any prescribed rules. This observation has been remarkably verified by our author. There is scarcely a page of the work now before us, in which his inventive genius has not, while it conducted his grand philosophical analysis, developed some new occult mathematical relations. The principal object of the Principia, to use the words of Dr. Pemberton was, "to search out and distinguish the springs of natural operation; a work infinitely more difficult to accomplish than even the greatest improvements he has made in pure mathematics, which were previously necessary, in order to his succeeding in his researches into the knowledge of nature; for in this last pursuit he has given proof not only of a more unbounded invention, than is required in the subtlest geometrical speculations, but has also there discovered the greatest discernment and consummate judgment, since in his philosophical writings, he has never once been imposed on by an hypothesis, nor by any of the various fallacies which my Lord Bacon in his novum organum, has reckoned up as the causes that had hindered the improvement of the true philosophy." To a mere mathematician, however, the great mathematical inventions of this work, will appear not less valuable, than those in philosophy. Among these we account this doctrine of prime and ultimate ratios, many geometrical problems of the 4th and 5th sections of the first book, the invention and frequent use of the fluxional calculus, Taylor's theorem in substance, the differential method, and numberless minor inventions. How the inventor of these could be supposed to be wanting in analysis, is truly unaccountable. The truth is, that he is the inventor of the analysis of infinites, of their development by his Binomial Theorem, and of innumerable refinements in algebra. These are the fundamentals of the modern refined analytics, which our author originated as an auxiliary to this great philosophi-

* Vide Simson's preface to Eucid's Data.

cal work, for, of them, if he was not the sole, he was certainly the principal inventor; of his philosophy, nothing can be said, more or less, than that it is entirely his own, and by the power of truth, has subverted the Aristotelian, Cartesian, and all other systems.

The 11 preparatory Lemmas in our opinion, are the most concise, perspicuous, and complete demonstrations of the vanishing ratios of variable magnitudes, which have ever appeared. The methods of Archimedes and of the ancients have always been considered as elegant and conclusive; but they dwindle very much when compared with those of Newton; and I know not whether any of the boasted methods of the modern analysts would not suffer even more in a comparison of that, which in the mathematics should ever be considered as the most important object, and as constituting its universal value, *logical evidence.*

The 7th, 9th, 10th, and 11th Lemmas, are the foundation of many of those intricate theories of curvilinear ratios, and of the variation of curvature which, since the time of Newton, from his hints, have been spun out into volumes. These ultimate ratios, in the sense of Newton, are not the ratios of variable magnitudes dependent on one another, while they actually have an augmentation or diminution, for unless they have always to one another, a constant ratio, that ratio must vary from the true ratio of variation at the very point from whence the variation commenced; neither is it the imagined ratio of the quantities, when their movements have actually vanished, called by Berkley, the *ghosts of departed quantities;* but it is the ratio under which they vanish, or the last ratio they had before they vanished. These ratios are denominated by Newton ultimate, as implying that no other ratio between them and their limits, can be taken. The limits, therefore, as approximating to them by less than any finite difference, are the proper, determinate, and only fixed ratios in question.

The modern analytical methods, which consist in assuming the second term of a developed function of an increment as that ultimate ratio, is either a mere assumption, or it must be founded on the same logical principles of reasoning. In some parts of this work, and more particularly in the quadrature of curves, we have the substance of this theory of derivative functions, as will appear in the sequel of our review. The 2d section, or the first which relates to the general sub-

ject of the analysis of forces, is employed principally on such as are situated in the centre of the figure, and of consequence embraces all the theorems of circular motion, which had been before treated of by Hooke, Huygens, and others, but going far beyond them. In this part are demonstrated, for the first time, the laws of Kepler, and the formulas for the centripetal force as dependant on the velocity of a body, and the chord of curvature of the osculatory circle. The author applies them to the principal and most elegant propositions of motion in the circumference of a circle, and investigates a theorem for the law of force transferred from one point to another. We then have the investigation of the force requisite for a body to move in the logarithmic or equiangular spiral, which constitutes the principle on which the motion of the apsides depends; and, lastly, the variation of force necessary to cause a body to move in an ellipsis describing equal areas about its centre. The second demonstration of the 10th proposition is incomparably fine, and the corollary and scholium very important deductions. The propositions themselves have also a variety of valuable applications in astronomy; that law of force, for instance, which is necessary for a moving body to make no deflection in its direction from the radius Vector, is not only that from which proceeds the motion of the apsides and the variable eccentricity of the lunar orbit, but it is that which causes any planet or comet, moving in an ellipsis, when it has arrived at its perihelion, or nearest distance from the sun, to recede from it in an equicrural curve, through a deficiency of centripetal force to retain a body moving in a circular orbit, while it described equal areas in equal times; for that force must be in the inverse triplicate ratio of the distance. This ratio of force is the only power by which circular motion, or any equiangular motion, can be maintained at different distances, under the above-mentioned conditions. All other laws of force will produce different angular directions with the radius vector, and must ultimately terminate in an apsis or a rectilinear direction, coinciding with the radius vector.*

* The converse of this problem, viz. that the law of the force being in the inverse triplicate ratio of the distance, the body will move in an equiangular spiral, will not obtain, but in particular cases, as may be inferred from the author's 41st proposition, and is admirably illustrated by Dr. Keil, in number 340 of the philosophical transactions. The curve would more generally be the hyperbolic spiral, the most remarkable property of which is, that motion in this curve will always produce equal centripetal and centrifugal forces, and therefore the paracentric velocity is uniform.

Prop. 8, Prob. 3, is but a particular case of a general problem, which our author has solved according to the modern analysis, in the scholium of the 13th section of the first book; viz. by a development of the function of the ordinate; and here we have the origin, and indeed the whole substance of Taylor's celebrated theorem, which shows the relation between the increment of a function and its different orders of fluxions. The second term of the development is proportional to the first differential; the third term will be proportional to the second differential, &c. This is demonstrated in Newton's quadrature of curves, by Stewart, and in other comments on his works. Now, as the second fluxion of the ordinate is known to be proportional to the force, or generally $\Phi \propto \frac{\ddot{s}}{\ddot{t}^{2}}$, the third term of the development, which is proportional to it, is made by Newton the expression of the force. If, for example, the curve be a parabola, and the force be supposed to act in the direction of the ordinate, we shall have $y = a^{\frac{1}{2}} \propto^{\frac{1}{2}} \propto x^{\frac{1}{2}}$, and $\dot{y} \propto x^{-\frac{1}{2}}$, (and $\ddot{y} \propto x^{-\frac{3}{2}}$,) or as $\frac{1}{y^{3}}$, or the force, as $\frac{1}{y^{3}}$. If the abscissa be assumed as the ordinate to a co-ordinate axis, then $x = \frac{y^{2}}{a}$ and $x \propto y^{2}$ and $\dot{x}\ (\propto 2\, y\, \dot{y}) \propto 2\, y$, and $\ddot{x}\ 2\, \dot{y}\, \dot{y}$, or the force is constant, as we know also from other principles. Any of the conic sections will require the same law of force, acting according to the direction of its ordinate. If it be a higher curve of the same class, the force may easily be found in the same manner; which solution, together with the innumerable fluxional problems solved in the Principia, as well as in the earlier productions of Newton, long before the forms and rules of the fluxional or differential calculus were published, prove that this noble science owes its existence to our great author. We further add, that the second and third sections now under consideration, have originated a new science, viz. the philosophy of the heavens, denominated, sometimes, *celestial physics*, or celestial mechanics. These two sections, however, are not considered as comprising the whole of that sublime subject, as the author himself has treated it, and much

less, as it has been extended since his time; but they are the first revelations on this subject, and which none but the inventive genius of Newton probably would ever have made, though succeeding mathematicians such as the Bernouillies, Euler, De Lambert, Clairaut, and above all, La Place, have admirably improved the tools, and consequently very much refined the workmanship of our great author, and for which, I trust, they have amply been repaid by the eulogies of the learned world. It cannot be said, that they have, to any considerable extent, enlarged the philosophical or mechanical principles on which all their theories are founded. They are those of Newton, and no other could enable them by *a priori* deductions, to draw forth all the minute irregularities of the moon and other sattelites, of the motion of the comets in their eccentric orbits, and of the innumerable actions of those bodies, one on another. We may here conclude this number, which I much fear will prove too long for the reader, with a quotation from that elegant scholar and great astronomer, Dr. Halley.

> "Jam dubios nulla calligine prægravat error,
> Queis superûm penetrare domos, atque ardua cœli—
> Scandere sublimis genii concessit acumen.
> Surgite, mortales, terrenas mittite curas;
> Atque hinc cœliginæ vires dignoscite mentis,
> A pecudum vitâ longe lateque remotæ."

(To be continued.)

ART. VII.—*Notice of a recent discovery of the fossil remains of the Mastodon.* By JEREMIAH VAN RENSSELAER, M. D.

(Read before the New-York Literary and Philosophical Society, June, 1824.)

DURING a jaunt made last month, in company with Dr. Dekay and Mr. William Cooper, to the tertiary region of New-Jersey, we had the good fortune to disinter and to bring to the city the skeleton, nearly entire, of a mastodon, or mammoth, as it is colloquially, but improperly termed.

We were induced to search for these remains, from having seen lately exhibited at the Lyceum of Natural History, a tooth, which proved upon examination, to belong to this interesting genus, and which was said to have been found near Long Branch.

About three miles west of that watering place, is situated the farm of Poplar, occupied by Wm. Croxson, Esq. and owned by his father, who nearly six years ago began to reclaim a marsh, about a quarter of a mile from the house. This marsh was usually covered by about two feet of water, which was much increased, however, in wet seasons. The water was easily drained off, when, the moisture having evaporated, and the earthy particles consolidated, the surface sunk, very gradually, between two and three feet below its former level, except in those places where extensive beds of bog-iron-ore had been formed. These afforded an opportunity of judging pretty accurately of the subsidence of the present surface.

Last year, in crossiug this field formed by the reclaimed marsh, the attention of the proprietor was attracted by something sticking out of the ground, which proved to be a tooth. He then searched a little, and found part of the head of a large animal, partially exposed, being covered by grass only. With the assistance of a spade, he found other bones, which he took up and had removed to his house.

Visiting New-York this spring, he brought with him the tooth, which led us to enquire for the remaining portions of the skeleton.

Mr. Croxson had the kindness to conduct us to the spot, where we soon found sufficient inducement to dig, and in a short time our hopes were fully realized, and our most sanguine expectations surpassed. In the course of that and the following day, we recovered all the bones of the skeleton that Mr. C. had left, with the exception of two or three unimportant bones of a foot—unimportant, because we have the corresponding bones of the other foot. We were allowed by the liberality of the proprietor, to remove our treasures, with the exception of the bones of one foot, and some others which he wished to retain, and exhibit for the gratification of his friends. He kindly offered, however, to send them to us, with the addition of those which he had himself taken up.* We shall then possess very nearly a perfect skeleton from this locality, viz :—

The head much injured, and without tusks, but with two teeth.

Twenty-two vertebræ, more or less perfect, commencing with the atlas, and terminating with the os sacrum.

* Mr. Croxson has since sent them to the Lyceum.

Eleven ribs nearly perfect, and many imperfect.
Two claviculæ.
Two scapulæ.
Half of the pelvis perfect.
The bones of the extremities, with the exception of three small bones of the right foot, viz :—

Of the fore extremities.

Two ossa humeri.
Two radii.
Two ulnæ.
Sixteen carpal, and
Ten metacarpal bones.
Twenty-eight phalanges.

Of the hind extremities.

Two ossa femoris.
Two patellæ.
Two tibiæ.
Two fibulæ.
Fourteen tarsal, and
Ten metatarsal bones.
Four sessamoidea.

Recapitulation.

Of the trunk.		
Vertebræ,	22	
Ribs,	11	
Pelvis,	2	
		35
Of the fore extremities.		64
Of the hind,		59
		158

Part of the head and two teeth.

It is to be observed that our skeleton was found much nearer to the ocean than any yet discovered, and is perhaps to be considered as one of the most perfect that we possess of that immense animal. The bones near the surface of the field, and within the influence of frost, have all suffered more or less; but as we proceeded down, they became more sound, and the bones of the legs and feet are perfectly solid,

and in excellent preservation. Many of them had small quantities of the phosphats of iron, and of lime, and small crystals of sulphate of lime, adhering to them.

Its position, corresponding with that of the skeleton found on the Wabash, was vertical, the feet resting on a stratum of sand and gravel, (mostly rolled quartz,) and the head to the west-south-west. There is every reason for supposing that the animal was mired in that situation, but at what period, we have no data even to conjecture. But we have authority for believing that the mastodon was one of the last animals that has become extinct. Zoologists, particularly zoological geologists, consider the doctrine as established, that the successive generations of organized beings that have dwelt upon the exterior of our globe, differ from the present generations, in proportion as their remains are more or less distant from the present surface; or, in other words, as the time in which they existed is remote from the present day. Now, according to this, the mastodon differs but little from some one of the living generations, (which we know to be the case,) and the deduction is fair, that if the living animal be not found, of which there seems now very little probability, its race has not long since perished, comparatively speaking. This conclusion is confirmed in my own mind by our researches after these very interesting remains.

Immediately under the surface, we found bog-iron-ore, loosely disseminated; in other places in the field it existed in abundance. A soft, black, damp earth, containing vegetable fibres, (what the Germans call *geest*,) continued down four feet from the surface. Beneath this we found a yellowish clay, tinged perhaps from animal decomposition. Below, thin and alternate layers of sand and black earth contiuued, until we met a small stratum of rolled quartz pebbles, covering sand, on which rested the feet of the animal, about eight and a half feet below the surface. These layers resemble those occurring frequently in Europe, and compose the greater part of our sea coast, from Long-Island to the Mississippi. They form part of the newer or tertiary formations, and are evidences of the last geological changes that the surface of our globe has experienced, always excepting volcanic and alluvial, still in daily operation.

Of the genus mastodon, there are two distinct species, viz. the M. *giganteum* and the M. *Angustidens*, distinguished, as the names imply, by the size and by the configuration of

the teeth. Our animal belongs to the former species, of which, portions of many individuals have been found on our continent, and a few, comparatively, in Europe. The beauty and value of these organic remains induced us to present them to the Lyceum of Natural History of New-York; and we have the satisfaction of knowing that they constitute an important addition to the fine collection of fossils in the cabinet of that valuable institution.

ART. VIII.—*Account of some new Vesuvian Minerals, by Sigg.* MONTICELLI *and* COVELLI. Translated by Dr. J. VAN RENSSELAER.

TO THE EDITOR.

DEAR SIR,

I sent you some time ago, a compressed account of the report on lightning-rods, made to the French Academy of Sciences, by M. M. Charles, Gay-Lussac, and de Romas, which you published in the 9th vol. of your valuable Journal. I have now the satisfaction to forward to you an account of *some new Vesuvian minerals*, which I have translated from the new work, in Italian, of Sigg. Monticelli and Covelli, of Naples, entitled, "Prodromo della Mineralogía Vesuviana," which they have kindly presented to me, together with a suite of the newly discovered substances.

Very respectfully, yours,

JER: VAN RENSSELAER.

February, 1826.

N. B. The terms describing the varieties of the crystals, are literally translated, and refer to the plates of the original work—they are exhibited here in wood cuts.

CLASS III.

Species not yet classified, or altogether new.

BREISLAKITE.

Specific characters.

The appearance of this singular species, is that of a brownish or reddish-brown down. Under the microscope, it ap-

pears in form of extremely small, straight acicular crystals, of red colour, which are placed in the interstices of other extremely small crystals, capillary, contorted and brown. Nitric acid, when cold, does not attack breislakite, but when heated, reduces it to a most impalpable yellow powder, which, on cooling, is precipitated. In the flame of a lamp, this down is heated without alteration, but before the blowpipe, it melts into a black enamel.

Locality. The breislakite lines the small bubbles found in the lava of Scalla, where it is accompanied by muriate of copper, pseudo-nepheline, and some small yellowish-white undetermined crystals. It is also found in cavities in the lava of Olebano, near Pozzuoli, and is there distinguished by its reddish-yellow colour.

Wollaston alone has analyzed this mineral; according to him, and our own observations, it consists of silex, alumine, and a little iron.

HUMBOLDTILHITE.*

(Umboldilite.)

Specific characters.

Geometrical characters. The primitive form is a right rectangular prism, with a square base—the plane G being to B nearly as 20 to 39.

Physical characters. Sp. gr. is 3.104—it scratches glass, is translucent in mass, transparent in thin laminæ—has a vitreous lustre in some crystals—fracture vitreous and conchoidal—but the fragments are irregular acuminated pieces. The colour is brown, tending slightly to brownish-yellow in some crystals. The small splinters have no colour.

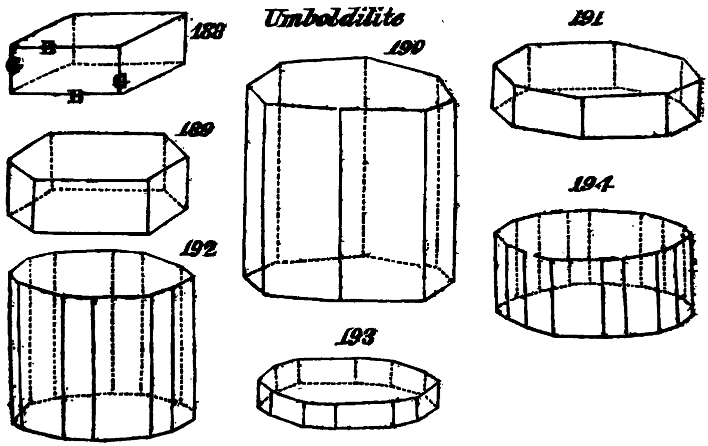
Chemical characters. Pulverised and treated with nitric acid, it is converted into a perfect jelly.

Exposed to heat, the point becomes rounded without changing color, and preserving its transparency, but before a blowpipe, with a strong heat, it melts with effervescence, without forming a globule. With *boracic acid*, before the blowpipe, it forms a transparent globule, which becomes translucent on cooling, without color. With *soda* it dis-

* We have chosen the word Umboldilite, to distinguish it from Humboldtine, (also in honour of Baron Humboldt,) which last name has been given by Sig. Rivero, a young Peruvian, to the suboxalate of iron, found in Bohemia, with strata of bituminous wood, at a great depth from the surface.

solves with extreme difficulty, and forms a brown opaque enamel. With the *phosphoric salts* it dissolves with equal difficulty, and forms a globule, translucent under the flame, but changing to a brown opaque enamel on cooling, owing to a deposit of silex.

Varieties. 1. It occurs of the primitive form. (see figure 188.) 2. Peri-hexahedral. (fig. 189.) 3. Peri-octahedral. (fig. 190.) a. The same shortened. (fig. 191.) 4. Peri-dodecahedral. (fig. 192.) a. The same shortened. (fig. 193.) 5. Peri-dioctahedral. (fig. 194.)



Also cylindrical, and in a translucent vitreous mass of a greenish yellow color.

Dimensions. The crystals of the primitive variety do not exceed three millimetres in length, at the base, and one and a half in height. The hexagonal variety is larger, having a length of fifteen millimetres, and a height of seven.

Color, brown, inclining, slightly to yellowish, or greenish yellow.

Locality. The humboldite occurs in aggregate; viz:

1. In an aggregate composed of particles of zurlite, yellowish and amorphous, and of pyroxene, also amorphous, and greenish brown, the particles adhering forcibly, and in some masses appearing united by fusion. The mass, at times, assumes the different aspects of porous and fine grained, and compact lava.

2. In a greenish brown compact rock, which at first sight resembles petrosilex, but is, in reality, somewhat similar to the aggregate just mentioned, containing imbedded nodules of compact lime, of a livid brown color.

3. In a whitish brown rock, similar to the preceding, containing fine grains of calc spar.

4. An aggregate similar to No. 2, into which pyroxene enters as a constituent.

All these aggregates are found as nodules in the matters ejected by early eruptions.

The minerals most frequently accompanying this substance are fibrous and shining Thompsonite—mica, spinelle, pyroxene and spathic carb. lime.

According to analysis, it is composed of

Silex	54.16	containing oxygen		27 - - -	9
Lime	31.67	"	"	9 - - -	3
Magnesia	8.83	"	"	3 - - -	1
Alumine	.50				
Ox. of iron	2.00				
	97.16				
Loss	2.84				
	100.				

The formula expressing the chemical composition of this new Vesuvian mineral is $3CS^2+MS^3$.

In order to compare the position of the Umboldilite with the double silicates of lime and magnesia, which it most nearly approaches, their formulæ are added.

Umboldilite	$3CS^2+MS^3$
Melihite	$3CS+4MS+fS^3$
Common pyroxene	CS^2+MS^2
Malacoltie	$2CS^3+MS^2$
Common amphibole	$CS.^3+2MS^2$

Characters distinguishing the Umboldilite from other species to which it approximates by chemical or geometrical characters.

The umboldilite approaches, by its primitive form, the following: anhydrous sulphate of lime, cryolite, cymophane, peridot, stilbite, dipyre, and analcime.

The chemical and physical characters show a great difference between this and the first two on the list: from cymophane

and peridot, it is known, because these minerals do not form a jelly with acids, and are infusible before the blowpipe; the umboldilite being the reverse in both points. It is distinguished from stilbite and analcime by forming jelly with acids, which those minerals do not;—and from dipyre, by its chemical composition—that mineral containing no magnesia.

In chemical composition, the umboldilite approaches pyroxene, malacolite,* amphibole and melilite. The power of forming jelly with acids, distinguishes the umboldilite from all these species: the facility with which it fuses, and its primitive form, distinguish it particularly from the three first. Amphibole and grammatite have a different primitive form, and are differently affected by the blowpipe. It approaches nearest to melilite, but is different as seen by their formulæ: the latter being $3\,C\,S+4\,M\,S+fS^3$—and the umboldilite having $3\,C\,S^2+M\,S\,3^3$. The melilite melts easily before the blowpipe, into a bottle green glass, and the umboldilite fuses with difficulty into a colourless glass. Melilite has a honey yellow, or brownish red colour, while the umboldilite is brown, inclining slightly to yellowish or greenish yellow.

Zurlite.

Specific characters.

Geometrical Characters. The primitive form, according to Ramondini, the discoverer, is a cube; but according to the authors, a rectangular prism of the same dimensions as the last.

Physical Characters. Sp. gr. 2.274.

It does not scratch glass—is scratched by the knife. The surface is rough and dull, of asparagus colour, while the raspings have the gray colour of clear pearl. The fracture is granular—lamellar, the grain fine and dull—the lamellæ very thin and adhering to brown calc spar.

Chemical Characters. Pulverised and placed in nitric acid, it effervesces instantly, and then subsides into a greenish imperfect jelly.

Before the blowpipe, the greenish splinters, which are the least impure, melt by a strong heat, with partial effervescence, the point changes to a greenish yellow translucent enamel, compact when the effervescence is finished, but vesic-

* In the system of Haüy, malacolite and pyroxene belong to the same species.

ular if the fusion is suspended before the effervescence terminates. The splinters washed in nitric acid, i. e. free of calcareous laminæ, melt more easily, and with more effervescence.

Varieties. 1. Primitive. 2. Peri-hexahedral. 3. Peri-octahedral. 4. Peri-dodecahedral. a. the same shortened.

Also, cylindrical, and in form of a compact, opaque mass, of asparagus colour.

Dimensions. The largest crystals of the primitive variety are 14 millimetres long, 12 broad, and 7 high. The other varieties, particularly the 4th, are 21 by 15.

Locality is perfectly analagous to that of the umboldilite.

Observations. The crystals of zurlite have generally the appearance of grés, or sandstone. The superficies rough and granular, of a green colour, more or less dirty. The angles of the crystals are more or less rounded, so that the prisms pass easily into cylinders. Some crystals occur imbedded in a whitish carb. of lime, which is spread thinly over the surface, like a varnish.

The crystals of zurlite have a heterogeneous structure, and appear as if composed of umboldilite, pyroxene, and carb. of lime, in mechanical combination, the former predominating and giving the primitive form. There are some crystals that exhibit, in some spots, particles of pure umboldilite, and at others a mixture of the three species. All this shows clearly that the zurlite appertains to the umboldilite, of which it seems a sub-species.

The zurlite was discovered by Ramondini, who published a notice of it in the Neapolitan Encyclopedia.

DAVINA. *(Davyne.)**

Specific characters.

Geometrical Characters. Primitive form, a regular exahedral.

The height of the prism is greater than the breadth.

The natural joints are very visible.

* In honor of Sir Humphrey Davy.

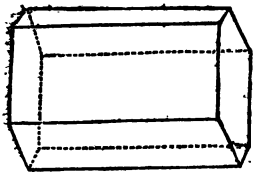
Auxiliary Characters. Texture laminar—the direction of the laminæ parallel to the axis of the prism. Ordinary colour is brown; with pearly or opaline lustre.

Physical Characters—Sp. gr. 2.25. The lustre is opaline in the transparent crystals, pearly in the opaque. The colour is brown in the former, white in the latter. The texture is laminar, the laminæ being parallel to the axis of the prism. The laminæ of transparent crystals adhere so closely to each other, as to give it the appearance of compact texture to the naked eye. In the opaque and translucent crystals the laminæ are very apparent, and easily separated. The transverse fracture is unequal,—vitreous in the transparent and translucent crystal, and dull in the opaque. The longitudinal fracture is laminar.

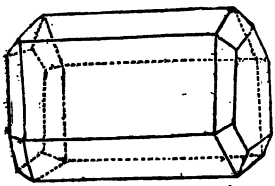
The Davina shows double refraction in its laminæ.

Chemical Characters. Pulverised and treated with nitric acid, at the ordinary temperature, it produces a momentary effervescence, (owing to a small quantity of carb. of lime, mechanically combined with it,) and then subsides into a yellowish perfect jelly, rather cellular.

Nitric acid in which Davina has been digested, dissolves when cold, about 0.50. Before the blowpipe alone it melts with effervescence, and is reduced into a white opaline enamel, somewhat porous. The laminæ exposed to the simple flame of the lamp, do not lose their transparency, which is preserved even at white heat under the blowpipe. When pulverised and moistened, so as to be exposed on charcoal to the flame of the blowpipe, it melts and forms a cellular enamel. *With soda*, it dissolves imperfectly, and eventually forms a globule of opaque enamel. With *boracic acid*, exposed on platina wire, it forms a limpid colourless globule. With the *phosphoric salts*, in just proportions, it affords a milky opaline globule, which is opaque when warm, but translucent on cooling.



Davina 194 (bis)



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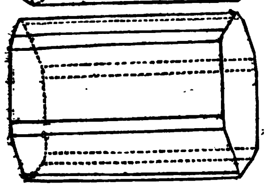

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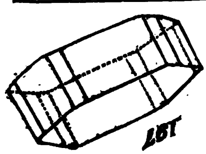


197

Varieties. 1. Primitive—(see fig. 194 bis.) regular hexahedral prism, of which the height is always greater than the breadth. 2. Annular—(fig. 195.) 3. Peri-dodecahedral—(fig. 196.) *a.* the same shortened—(fig. 197.)

Dimensions. The usual size of these prisms is 8 millimetres in length, by 4 in width; they do occur 15 by 10—and the largest even 30 by 20. *Colour* is brown. It is found transparent, translucent and opaque: and with pearly or opaline lustre.

Locality. It occurs in a rock analogous to that in which the Umboldilite and zurlite are found. These, however, very rarely occur with Davina. The crystals usually accompanying Davina, are Wollastonite, Garnets, calcareous spar, pumice, black spinelle and mica.

Distinguishing Characters. It approaches nearly to Nepheline, by its crystalline form, by its action under heat, and with acids, but has characters so marked as to distinguish it at first sight.

Comparison of the characters of the two minerals.

Davina.	*Nepheline.*
Primitive form, regular, hexahedral, the height of the prism greater than the width.	Primitive form, regular, hexahedral, the height of the prism less than the width.
The natural joints, especially those parallel to the lateral faces of the hexahedral, are very apparent.	The natural joints are scarcely apparent, and only seen by aid of a strong light.
The prisms of the secondary form are less long than broad.	The prisms of the secondary form are less broad than long.

The crystals are more dull on the superficies, and have an opaline lustre.	The crystals are always splendent.
The longitudinal fracture is laminar, the transverse is unequal and vitreous.	The fracture is vitreous, conchoidal, and a little splendent in all directions.
Nitric acid takes up 50 in the 100.	Nitric acid takes up the smallest possible quantity.
Sp. gr. 2.3.	Sp. gr. 3.27.
With phosphoric salts, in just proportions, before the blowpipe, gives a milky, opaque globule.	In the same salts yields a pearl of transparent glass, which becomes opaline on cooling.
With soda it melts imperfectly into an opaque enamel.	——— into a glass without colour.

Finally, the chemical composition is totally different. It is known from the mezotype of Haüy, because its natural joints exhibit the rectangular hexahedral, while the mezotype has the straight conchoidal prism. The fracture of the Davina is laminar, while that of the mezotype is vitreous—the former scratches glass, the latter carb. lime.

It differs from the Thompsonite and pseudo-Nepheline. The form of the Thompsonite is derived from the straight rectangular prism; that of the Davina from the regular hexadral. The latter scratches glass, the former fluate of lime. The laminæ of Thompsonite lose their transparency before the flame of a lamp, while the Davina does not lose it even at a much higher temperature.

Pseudo-Nepheline approaches much nearer to Davina than to Nepheline, by its primitive form, by the disposition of the natural joints on the base of the prism, and by its power of forming jelly with acids. There are also the following distinctive characters. The sp. gr. of Davina is 2.03; that of pseudo-Nepheline is 2.18. Before the blowpipe, the latter melts with extreme difficulty, the former very easily. Nitric acid takes up 50 of the Davina—not ⅓ part of that quantity of pseudo-Nepheline. By the external aspect and usual size of the crystals, they are easily distinguished—the pseudo-Nepheline having an ordinary lustre, while the Davina is pearly or opaline. The structure of the latter is always lamellar, while the other is only occasionally so in some crystals. Finally their chemical composition is entirely different.

The Davina, according to analysis, has in the 100 parts

Silex	42.91	containing	oxygen	21.58	7
Alumine	33.28	"	"	15.54	5
Lime	12.02	"	"	3.37	1
Iron	01.25				
Water	07.43	"	"	6.55	2
Loss	03.11				
	100.				

The formula should then be $CS^2+5AS+2aq$: i. e. one atom of bisilicate of lime, five of silicate of alumine—due* of water. The species to which it is nearest allied are added, with their formulæ, viz.

Zeolite of Borkhult, $=CS^2+3AS$.
Prehnite of Konfolite, $=CS^2+2AS$.

CAVOLINITE ?

This species was first offered to our consideration, as a sub species of Davina, and as such was placed in the series of Vesuvian specimens in our collection. But in submitting some crystals of Davina to analysis, some of these were employed, and yielded a different result, having potash as a constituent. This led to a minute examination of the supposed sub species, which is now to be considered a species entirely distinct from Davina. The authors publish this species as somewhat doubtful, not having opportunities to pursue their investigation, before their work appeared from the press. The name is given in honor of Philipo Cavolini, a Neapolitan naturalist, well known.

Specific characters.

Geometrical characters. Primitive form is a regular hexahedral; the height of prism less than the breadth. The prism divides with extreme facility, parallel to the axis, but the cleavages are very indistinct, and the mechanical division very difficult.

Physical characters. It scratches glass. The crystals are always opaque and white: the lustre pearly or silky. Longitudinal fracture fibrous, lamellar, silky. Transverse fracture rough and unequal. Sp. gr. 2.15.

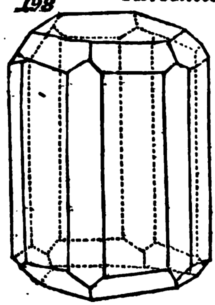
Chemical characters. When pulverised and treated with nitric, or idio-cloric acid, it is converted into a perfect jelly, without color. Before the *blowpipe* it fuses easily, with

* So reads the translation, and we have not the original.—Ed.

effervescence, and forms a globule of white enamel, with the aspect of porcelain. With the *nitrate of cobalt* it acquires a most beautiful azure. With *phosphorus*, in proper proportions, it gives a milky button, which remains opaque; but when the phosphorus is in excess, the button is transparent when warm, but opaque when cool.

Varieties. 1. Primitive. 2. Annular. 3. Peri-dodecahedral. 4. Emarginate. (fig. 198.) 5. The same shortened. (fig. 199.) 6. Pyramidal. (fig. 200.) 7. The same shortened. (fig. 201.)

198 *Cavolinite*



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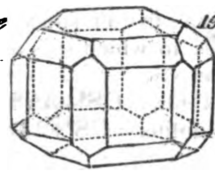
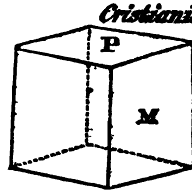


Cristianite

202



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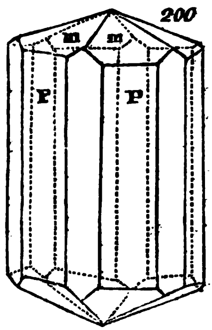

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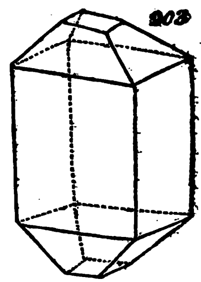

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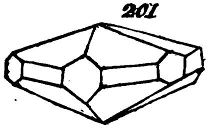


Dimensions. The crystals are usually larger than those of Davina, but those of the primitive and annular varieties are small, passing into microscopic.

Locality. The Cavolinite occurs, 1st. In the interior of calcareous balls, accompanied by garnets, idocrase, mica, and granular pyroxene, which lines the cavity of the geode. 2d. In the centre of kidney-form aggregates, composed of calcareous grains and mica, tenaciously adhering. 3d. In a pyroxenic bomb, with pumice, crystals of pyroxene, and vitrified substances. 4th. In a fine grained trachyte.

Observations. The analysis of the Cavolinite, as well as its action before the blowpipe, leads to the presumption that this new species is a double silicate of alumine and potash,

and that it differs from all silicates of these bases, in having a larger proportion of alumine, and less of silex. The formula presenting its composition, is A^2S+KS. This will be verified by chemical examination.

Distinguishing characters. The structure, aspect of the crystals, and chemical composition, distinguish Cavolinite from Davina, Nepheline, and pinite, with which it has the primitive form in common.

The primitive form, its power of forming jelly with acids, and its chemical composition, distinguish it from scapolite, wernerite, spodumene, and prehnite.

It is distinguished from the mesotype of Haüy, which has a vitreous fracture; by having its fracture fibrous-lamellar, or silky, and by its containing potash, which the mesotype does not.

It is known from apophylite, by its forming jelly with acids, and melting only before the blowpipe; whereas that mineral dissolves in acids and before the blowpipe both. The Cavolinite has a regular hexahedral for its primitive form, the other, a right rectangular prism. Finally, the chemical composition of the two differs entirely.

CHRISTIANITE.

Specific characters.

Geometrical characters. The primitive form is an oblique rectangular prism, in which the inclination of base P (fig. 202) to the face M is 94°, and to the opposite, 86°. The natural cleavages parallel to M very distinct; those parallel to P, not visible.

Physical characters. Sp. gr. 2.77. It is scratched by quartz. The crystals have an ordinary lustre, but are mostly dull on the superficies, or incrusted with a yellowish brown varnish of pumice. The transverse fracture is vitreous, tending to conchoidal: the longitudinal is lamellar. The fragments are laminar, angular and irregular. The laminæ possess double refraction.

Chemical Characters. The Acicular fragments held for 20 minutes in the flame of the blowpipe, do not melt. The point most exposed becomes opaline, but resumes its ordinary aspect on cooling. With *phosphorus*, it yields a button of brownish glass, which becomes opaline when cool. With *soda* it fuses imperfectly, producing an opaque globule of enamel. With *borax* it affords a brown, globular, opaque button, translucent at the edges. With *nitrate of cobalt* the mass becomes brown, tending to blueish: but the edges ex-

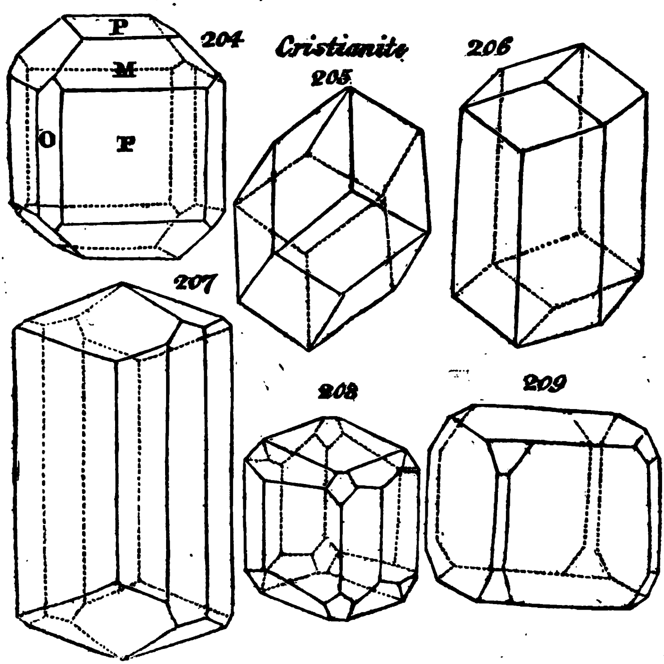
posed to a strong heat, acquire a beautiful blue colour, without melting.

When pulverised and exposed, in a platina crucible, to red heat there is no loss.

The sulphuric, nitric, or idiocloric acids partially dissolve it, and the solution gives with ammonia, a precipitate, which with cobalt before the blowpipe, becomes blue. The liquid deprived of the precipitate, gives with oxalic acid, a precipitate of brown colour.

Sulphuric acid acts in a singular way on the Christianite, altering very considerably the bulk, and converting it into an imperfect vesicular jelly. To obtain this result, it should be finely pulverised and washed in sul. acid, with its own weight of water.

Varieties. 1. Quadri-decimal—(fig. 203)* 2. Octodecimal—(fig. 204.) 3. Regular dodecahedral—(fig. 205.) *a.* Dodecahedral elongated—(fig. 206.) 4. Dioctahedral—(fig. 207.) 5. Dieci-sesdecimal—(fig. 208.) 6. Blunted—(fig. 209.) 7. Defective—(fig. 210.)† 8. Bisduodecimal—(fig. 211.)† 9. Hexahedral—(Christianite ?)



* For this figure, see the preceding group, p. 260.

† For these figures, see the *succeeding* group, p. 265.

Dimensions. The large crystals are 30 millimetres in length, 22 in breadth, and the same in thickness. Still it is difficult to measure them, as they are mostly broken at the angles, imbedded in the matrix, or covered with pumice.

Colours. Brown, yellow and reddish. It occurs transparent, translucent, and opaque.

Position. It is found in small geodes of granitoid aggregates, composed principally of pyroxene and mica. Most of these aggregates have their interior full, or studded with crystals of other substances, passing into enamel, pumice, scoriæ, or obsidian. Among these volcanic substances are found crystals of Christianite, sometimes perfect, or split, or broken —semi-fused externally, or covered with a coating of pumice or enamel. The aggregates of this nature are mostly uniform or globular, and are found in the matters ejected at different eruptions—especially in beds of volcanic sand or ashes.

The crystals most frequently accompanying this mineral, are pyroxene and mica—more rarely hornblende, haüyne, idocrase, and meionite. These are found in the same geode intimately grouped with it—penetrating its crystals, or being penetrated by them.

This mineral is found in the current of lava at Pollena, especially the hexahedral variety, which is accompanied by phosphate of lime, melilite, mica and quartz.

Distinguishing Characters. Its form being derived from the the oblique rectangular prism, distinguishes it from phosphate of lime, the form of which is derived from the regular hexahedral. It dissolves partially, the phosphate entirely in nitric acid. Sp. gr. is 2.77—2.92; that of the phosphate is 3.0—3.2.

The topaz, peridot and chondrodite are infusible, like the Christianite, but the topaz scratches quartz, which in its turn scratches Christianite. The sp. gr. of topaz, is 3.56. —that of Christianite 2.9. The form of peridot is a straight rectangular prism; that of Christianite an oblique rectangular prism. The sp. gr. of peridot is 3.4. The chondrodite has the oblique rectangular prism for its primitive form, as has the Christianite; but in this the lateral face is to the base as 94° to 86°—the chondrodite is 112° 12′ and 67° 48′. Nitric acid has no power on chondrodite, but dissolves a portion of Christianite. The colour of Christianite is rarely yellow—

that of chondrodite is yellow, or brownish yellow. Finally, the infusibility of Christianite distinguishes it from all zeolites, from Nepheline, felspar and amphigene.

BIOTINA.

This was at first confounded with the last mentioned mineral, and is separated from the conviction that its figure cannot be derived from the primitive form of that mineral. It is announced as new to draw the attention of mineralogists to it, and to the series of Vesuvian crystals which belong to this species, and which distinguishes it from all hitherto found on this volcano, by its limpidity and splendour—by its infusibility, and by its system of crystalization. The name is proposed in honour of Biot, a distinguished French naturalist, well known for his attainments in the physical sciences.

Specific characters.

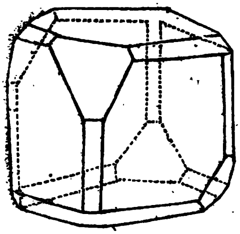
Geometrical Characters. The primitive form is an obtuse rhomboid—(fig. 212.) The angle of P with P′ is 94°, and that of P and the opposite face is 86°. The other angles are 114° 20′ and 65° 40′. The face AE is rather larger than AE′.

Physical Characters. Sp. gr. 3.11. It scratches glass—lustre very vivid—fracture vitreous, tending to conchoidal. Fragments angular and irregular. All the crystals possess double refraction, as was verified by Mr. Biot at Naples.

Chemical Characters. The acicular fragments held for a long time in the flame of the blowpipe were unaltered. Nitric acid partially dissolves it without forming a jelly.

Varieties. 1. Bis-marginate—(fig. 213.) 2. Tri-tetrahedral—(fig. 214.) 3. Sei-duodecimal—(fig. 215.) 4. Octo-duodecimal—(fig. 216.) 5. Octo-sesdecimal—(fig. 217.) 6. Amphi-hexahedral—(fig. 218.) 7. Amphi-octahedral—(fig. 219.) 8. Quadri-duodecimal—(fig. 220.)

210



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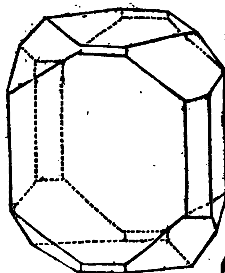

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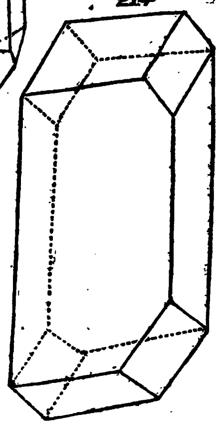

Biotina

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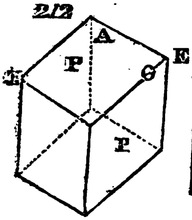

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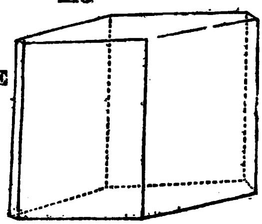

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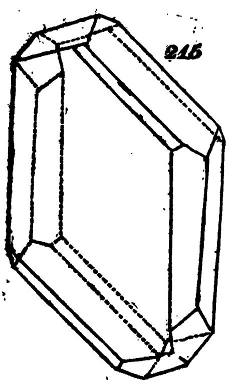

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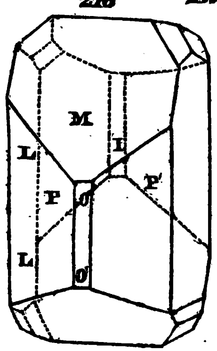
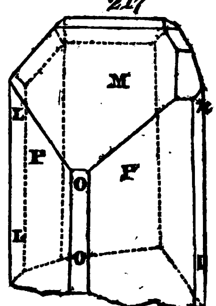


Biotina

217



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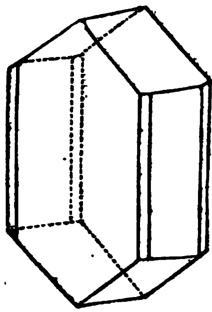

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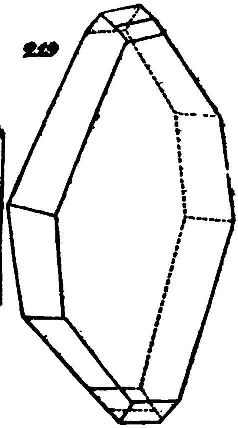

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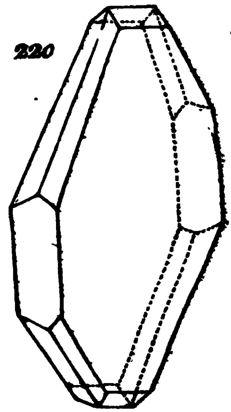


Colours. Topaz-yellow, brown, and colourless. It is found limpid and transparent.

Dimensions. The largest crystals hitherto found do not ordinarily exceed six millimetres in diameter. One crystal of the fourth variety has 12 millimetres length, 8 breadth, and 6 thickness.

Position. Granitoid aggregates of pyroxene and mica usually contain Biotina mixed with its fragments. These aggregates are not firm, and are found in the matters ejected in different eruptions. The crystals are distinguished from those accompanying them, by their superior splendour.

Distinguishing Characters. It is easily distinguished from those crystals which have the same primitive form, as carb. lime, carb. of barytes, carb. of strontian, quartz and chabasie, since the three first species are scratched by biotina, and effervesce with acids, quartz scratches it, and the chabasie fuses before the blowpipe, which biotina does not.

Deriving its form from the obtuse rhomboid, it is distinguished from the phosphate of lime, which has the regular hexahedral prism. It dissolves in very small portion, while the phosphate of lime dissolves perfectly in acids.

It is distinguished from peridot and chondrodite by its primitive form, by the development of its secondary form, and by its aspect. It is known from cymophane, which strongly scratches quartz, while this scarcely scratches glass. Cymophane has the straight rectangular prism for its primitive form, while Biotina has the rhomb.

Foliaceous Copper.

The chimnies constantly burning on the east of the crater of Vesuvius have furnished a sublimation, composed of acicular and rectangular laminæ, some of such extreme subtility and fragility, that it is scarcely possible to procure them entire, since they are broken by the slightest jar, or even agitation of the air. Viewed at an oblique angle, they present the brown colour of shining steel, but seen perpendicularly, they exhibit a velvet brown. Formed in the interior of these chimnies, the laminæ and their matrices are accompanied by muriate of soda; and are often imbedded in this salt, which takes the green colour of the metal. The matrix is usually an aggregate.

The thickness of these leaves is about 4 lines, resembling similar plates of gold or silver, but are much more frangible. They dissolve quickly in nitric acid, without a residuum, imparting a beautiful green colour, which is changed to indigo blue by the addition of ammonia; a certain indication of copper. An exact analysis of the sublimation has not yet been made.

It appears probable that this metallic sublimation is not produced by heat solely, but is favoured by an acid, which renders the metal fragile. It is so intimately combined with muriate of soda, as not to be freed from it by washings with distilled water. Still it may be doubted if either the muriatic or the arsenical acid is concerned in its formation. The authors will institute experiments to ascertain that point.

Art. IX.—*An arrangement of the genera of Batracian Animals, with a description of the more remarkable species; including a Monograph of the Doubtful Reptils.* By D. H. Barnes, A. M., Recording Secretary of the New-York Lyceum.

(Read before the Lyceum, July, 1825.)

The distribution of the class *Amphibia*, or Reptils, into four orders, affords a fair example of the exact method of modern science. A tortoise, a lizard, a snake, and a frog, are objects familiar to all; and these animals being assumed as the types of the orders, give a natural clue to guide us in our investigations. It is in this department that the chief labor remains to be done, in order to illustrate the natural productions of the Western Continent. Our reptils are numerous, and some of them are peculiarly interesting. We have, in our waters and marshes, nearly all of that singular family, which have been supposed to possess a double set of respiratory organs. Most of these have lately been subjected to the strictest scrutiny; and to bring together the scattered rays of light, and give a clear view of the subject, is the principal design of this paper. It was written for the purpose of fixing the author's own views of an obscure and intricate subject, and it is published with the hope that it may be useful to others. A catalogue even of the synonyms cannot be unacceptable; for, if properly arranged, it will facilitate the labor of future inquirers.

REPTILS.

Order 1.—Chelonian.

Characters. Four legs, a tail and shell.
Examples. Tortoises and Turtles.

Order 2.—Saurian.

Characters. Four legs, a tail and scales.
Examples. Lizards and Crocodiles.

Order 3.—Ophidian.

Characters. No legs, a tail and scales.
Examples. Serpents.

Order 4.—Batracian.

Characters. Legs, but no scales or shell.
Examples. Frogs and Salamanders.

Methodical Table of the Fourth Order.

BATRACIANS.

First Division.—

Nostrils, but no spiracles.

* *Branchiæ and tail deciduous.*

(a) No teeth in either jaw.
1 Genus.—Bufo.
2 Genus.—Pipa.

(b) Teeth in the upper jaw.
3 Genus.—Hyla.
4 Genus.—Rana.

* * *Branchiæ deciduous, tail persistent.*

(c) Teeth in both jaws.
5 Genus.—Salamandra.

Second Division.—

Nostrils and spiracles.

* * * *Branchial opercula and tail persistent.*

6 Genus.—Menopoma.
7 Genus.—Amphiuma.

* * * * *Branchiæ and tail persistent.*

(a) Opercula subdivided.
8 Genus.—Siren.
§ Divisions simple.
Species.—S. Striata.*
§ § Divisions compound.
Species.—S. Lacertina.

(b) Branchiæ compound and fimbriated.
9 Genus.—Proteus.

* Since this paper was read, the Annals of Philosophy for September, have been received, in which the name *Pseudobranchus* is proposed, by Mr. Gray, as a genus to include this species. The adoption of a new name in this case, does not appear to serve any useful purpose.

Addditional note communicated by the author, Aug. 15, 1826.

The delay in the printing of this paper, has given the author an opportunity of announcing, in this place, the discovery of ANOTHER NEW SPECIES OF SIREN, by Capt. LE CONTE. It belongs to this section, and is called by its discoverer Siren Intermedia. In its color it resembles the *Lacertina*, and in its gills, the *Striata*; but it has peculiar characters of its own, which will be explained at length in a paper soon to be published in the Annals of the Lyceum. Length about one foot, inhabits the Southern states in large numbers. Specimens are preserved in the Cabinet of the Lyceum, Fig. Annals of the Lyceum, Vol. 2, fig. 1.

Remarks *on the preceding table.*

In this arrangement it will be perceived that the *divisions* depend on the presence or the absence of spiracles and tail. The *first six* genera agree in having *four toes* on the fore feet, and *five* on the hind feet. The *last four* agree in having *nostrils* and *spiracles*, or openings through the sides of the neck, like the gills of fishes. All, except the *eighth* genus, agree in having *four legs*, and divided toes, generally without claws. The *first five* have gills in their young state; and the gill-openings entirely closed, in their adult state. The *sixth and seventh*, have the gill-openings permanent, and covered by a simple, entire flap. *The eighth* Genus (§) has the operculum trilobate, and each lobe entire. *The eighth* genus (§§) has the operculum trilobate and each lobe divided into small parts, from five to ten in number, which lie parallel to each other. The *ninth* genus has the branchiæ large, projecting, subdivided, and ramified into numerous capillary processes. All, or nearly all, of this family of reptils, have teeth in the palate; the use of which is to triturate their food while the mouth is closed; for, while the mouth is open, they are unable to breathe, and presently die, if they are prevented from closing their jaws. They all agree in being naked, that is, externally unarmed with scales, crust, or shell. They all appear to be innocent while alive, and innoxious as food.

We procede to the description of genera and remarkable species in the order above written.

BATRACIANS.*

First division.—Nostrils, but no spiracles.

* *Branchiæ and tail deciduous.*

(a) No teeth in either jaw.

1 GENUS.—BUFO. Toad.

Body warty and thick.
Legs four, short and clumsy.
Toes four before, separate and pointed.
" five behind, palmate or semi-palmate, and sometimes, the rudiment of a sixth.

Figures. Daudin. Ran. p. 71. Rept. 8. p. 137.
Synonyms. Rana bufo. *Linn.*
Le Crapaud. *Lacepede.*

* From Βατραχος, a frog, animals like frogs.

DESCRIPTION AND HABITS.

Toads produce eggs in a long double chain. They are hatched and continue in water during the tadpole state.—They inhabit dark and damp places. They feed on insects and fetid plants. They frequently assume different shades of color, in a short space of time. They seize their prey with a motion so quick as to be almost imperceptible. They climb soft and rough surfaces with facility. They leap commonly, tho with much less agility than frogs; and they crawl only where leaping is impracticable. Tho their warty and hideous appearance generally excites disgust, from the idea of their being poisonous, yet they are perfectly innocent, and in some countries are used for food. (DAUDIN.)—They live to a very great age, and have been known to frequent the same place for nearly forty years. Most authors agree that credit is to be given to the accounts of their being found inclosed in wood, mortar, and even rocks.

REMARKABLE SPECIES.

Rana Marina. Gmel. Fig. Daudin 37. This is the largest known species. Length 8–10 inches without the legs.

*Rana Cornuta. Horned Frog.**

Head and throat very large, with a large conical tubercle over each eye. Daud. 38. Seba 1. 72. 1. 2. This toad is of a hideous and deformed aspect. The mouth opens to half the length of the body. The body is covered with sharp spines, and striped and speckled, with yellow, gray, brown, and pearly.

Rana Margaritifera. This toad has, behind each eye, a crest which is stiff, curved and elevated.

Daud. 33. Seba 1. 71. 6. 7.

Remark. The generic name of all the preceding should be changed to Bufo; they would then stand correctly thus,

Bufo marinus.
Bufo cornutus.
Bufo margaritiferus, etc.

2 GENUS.—PIPA.† SURINAM TOAD.

Body, of the female, with cells on the back.
Legs four, of a moderate length.
Toes, four before, and each subdivided into four small parts.
" five behind, broadly webbed or palmate.

* The reptil of our western country, called *Horned Frog*, is a Saurian, described by Dr. Harlan under the genus Agama.

† From *pipare*, to cluck as a hen.

Figures. Brewster's Encyclopedia, pl. 298, fig. 21.
Shaw's Zoology, Vol. 3, pl. 31.
Seba's Mus. 1. p. 121, t. 77 f. 1—4.
Stewart's Elements, pl. 5. f. 2.

Synonyms. Rana Pipa. *Linn.*
Bufo dorsiger. *Daud. and Brewster's Encyc.*
Rana seu Bufo Surinamensis. *aliorum.*
Pipa. *Laurenti and Merrem.*

DESCRIPTION AND HABITS.

Body flattened horizontally; head large and triangular; no tongue! (CUVIER.) eyes small, and placed near the edge of the upper jaw; toes, of the fore feet, divided into four small toes, and these again subdivided. Inhabits Surinam, in obscure places under houses. When the eggs are laid, the male collects the mass, and, with his paws, spreads it over the back of the female. The eggs are received into little cells or openings in the back of the female, and then fecundated, and closed up by the male. The female betakes herself to the water. The eggs are hatched and pass the tadpole state in the cells, emerging perfect animals after a period of twelve weeks; during which time, the female remains in the water, and at the end of it she returns to land. She is said to produce young once only, but at that time she may bear seventy-five, which are all hatched within the space of five days. The natural deformity of this animal is rendered still more disgusting by the swelling and opening of the cells on the back. These cells present to our view one of the most remarkable instances of animal economy yet known. The throat of the male is furnished with a large, bony, triangular box, with a movable and bony apparatus for closing the bronchiæ. The animal is described like the *Siren lacertina*, and the *axolotl* as having *small claws;* but Cuvier says of the latter, " Les doigts se terminent comme ceux de la sirène par des phalanges plus pointues, mais aussi *sans ongles.*" Humboldt's Voyage, 1. 112. I believe that the whole family are destitute of proper *nails*, tho the phalanges are pointed, hard, and frequently of a darker color than the other parts.

Length of a full grown male, 7 inches.
" of a female somewhat less.

Of this very remarkable genus, the above is the only known species.

(b) Teeth in the upper jaw.

3 GENUS.—HYLA.* TREE FROG, or TREE TOAD.

Legs four.

Teeth, one row in the upper jaw.

Body tapering, skin viscous.

Toes before four, and behind five, all furnished with lenticular tubercles beneath. Toes of the hind feet semi-palmate.

Figures. B. Encyc. 298. fig. 19. *Daudin*, sæpe.

Synonyms. Hyla. *Laurenti.*

Rana arborea. *Linn.* Calamita. *Schneider.*

Ranunculus viridis. *Ray.* Rana tinctoria. *Shaw.*

La Rainette. *Lacepede.*

DESCRIPTION AND HABITS.

Body granulated beneath, assuming various colors, tapering behind, smooth and viscous, emitting a pungent scent; legs long, toes not properly webbed, furnished beneath with a round tubercle to each, by which the animals are enabled to adhere to the surface of even the smoothest substances. They appear to change their color voluntarily. They live on trees, to which they adhere by their tubercles, aided by the viscous matter which the toes secrete, and which, more or less, covers the whole body. It is supposed that they have also the power of exhausting the air from under their tubercles, and are thus assisted by the pressure of the atmosphere; for, when viewed through glass, to which they adhere, they are seen to have their tubercles flattened. They croak much during rainy weather, especially in the fore part of the evening. They copulate in April, and the young become perfect in August. For a particular description of North American species† see Annals of the New-York Lyceum of Natural History, vol. 1. p. 278.

4 GENUS.—RANA. FROG.

Body smooth.

Legs longer than the body.

Toes before, four, slender, cartilaginous, clawless.

" behind, five, palmate.

Teeth, one row in the upper jaw.

* From ὕλη, a wood or grove.

† By Capt. John Le Conte, of the U. S. Corps of Engineers.

Figures. Daudin. Ran. p. 45. Rep. p. 87.
Latreille, p. 136.
Dumeril. Zool. p. 91.
Schneider. Hist. Amph. p. 111.

Synonyms. Rana of *authors.*
Grenouille. *French.*
Frosch. *German.*

DESCRIPTION AND HABITS.

Body smooth and somewhat slimy. Legs long and athletic. Skin commonly of various colors. Frogs are very active animals, either on land or in water. They leap when pursued or disturbed, and if near the water they dive. When caught by the hand, they forcibly emit their urine, which is fetid and offensive. They produce their eggs in a large mass; breed in the water; and the young become perfect, in about two months. After a rain, they frequently come abroad in great numbers. They feed on worms, spiders, and insects; and even fishes are devoured by the larger species. They are eaten abundantly, in various places; particularly, we are told, at *Vienna*, where a scarcity of them would be an alarming public calamity. They are devoured by serpents, particularly by the garter snakes. *(Coluber saurita, et Coluber sirtalis.)*

When they find themselves pursued, they make prodigious leaps, and evince great terror; but when seized, they become perfectly quiet, and seem insensible of their danger. The snake seizes the frog by one of his hind feet, and very gradually draws it into his mouth. When he comes to the body, if not frustrated in his design by the largeness of his prey, or by accident, he draws in that also; and the other leg, inverted by the side of the body. When he comes to the fore legs, as they are both to be swallowed at once, he is frequently compelled to wait a long time before he can accomplish his purpose. When discovered in this situation, the snake and the frog appear, at a little distance, to form but one animal, resembling a Siren, with two legs close to the head. If the snake is now struck, the frog escapes. When a frog has been swallowed, the snake appears very much distended in the part where the prey remains, and it is said that the frog is sometimes extracted alive. It would seem very remarkable that snakes can manage to swallow frogs whose bodies are three times the circumference of their own, did we not know that their mouths and throats are very extensil.

In the opening of the spring, frogs emerge from their brumal retreats, and make a most tumultuous noise at night, croaking so loud as to be heard a mile off.

The story of the Windham frogs is famous in the Northern and Eastern states. It is variously told in prose and verse, and is, in substance, as follows. A mill pond was drained in the night. The frogs disturbed, set up a very loud croaking, by which the inhabitants were terribly alarmed; supposing that the day of final doom and retribution had arrived. Each, in his fright, fancied that he heard himself called by name, and accused of various crimes. Some confessed their secret sins and begged for mercy. Some promised restitution, and others acknowledged their accusations, and lamented in despair. All was tumult and terror, until the morning revealed the cause. The self-convicted criminals became the objects of unceasing ridicule.

REMARKABLE SPECIES.

The most remarkable species of frog is the Rana paradoxa, or Proteus frog of Surinam, which was supposed to turn into a fish, and is recorded by authors as having a tail. This is now well understood to be a mistake. The tadpole is enormously large in proportion to the fully developed animal, being eight inches long and three and a half inches broad, while the frog is but three inches long, and one inch broad.

Figures. Of the animal nearly perfect,

Brewster's Encyc.	298 f. 20.
Of the tadpole	295 f. 17.
Seba	1. 78.
Daud. Gren.	22 and 23.

This frog is called, by the inhabitants of Surinam, *Jakie*. Rana taurina, *Cuvier*, Rana pipiens, *Daud.* The American Bull frog is one of the largest species yet discovered.

Catesby,	2. 71.
Daud.	18.

In the four genera just recited, the eggs are fecundated by the male, after their emission from the body of the female.

HYBERNATION.

All the animals of the genera now enumerated, which live in the cold or temperate parts of the earth, appear to have similar habits of hybernation. They retire to the water, or to

the mud, or enter into holes and crevices, and there pass the winter in a torpid state. In this state they appear to remain stationary, needing neither food nor air, and neither increasing nor diminishing in size. They have been dug out of the earth in situations where they must have been confined for years, and perhaps for ages.

* * *Branchiæ deciduous, tail persistent.*

(c) Teeth in both jaws.

5 GENUS.—SALAMANDRA, SALAMANDER.

Body long and tailed.
Legs four, rather short.
Toes, four anterior, five posterior, without claws.
Skin smooth and scaleless.

Figures. Sonnini and Latreille Sæpe.
Synonyms. Lacerta Salamandra. *Linn.*
Triton. *Laurenti.*
Water Newts. Water Lizards. Evets or Ebbets.

Salamanders have a lengthened body, four feet and a long tail. They resemble lizards, and were so arranged by *Linne*, but they have all the characters of Batracians: head flattened; ear concealed under the skin; jaws furnished with numerous small teeth, and teeth in the palate; skeleton with movable rudiments of ribs. They respire by gills when young: in their mature state the gills are obliterated, and they respire by lungs, like frogs. They are all spawned in fresh water, but a part of them usually live on land. Hence they are divided into two great families, as follows:

1. LAND SALAMANDERS.—SALAMANDRÆ. *Laurenti.*

These animals have a flattened fin-tail when young, and they then reside in the water. In mature age, they reside principally on land, and have a *round* tail. They are produced alive, the eggs having been fecundated in the body of the female, by means of a milky fluid emitted into the water. When the tadpole drops his gills and fin-tail, he leaves the water, and becomes a land animal. The land salamander gives rise to the fable of living in fire, because when he is placed in it, he exudes a milky juice, which for a short time resists its action. What is more remarkable, is the opposite

quality of being able to resist cold, and to revive, after having been for a long while pressed under the ice.

2. WATER SALAMANDERS.—TRITONS. *Laurenti.*

These have, permanently, a vertically compressed tail. The male, during the pairing time, in the spring, has a crest and other ornaments, by which he is eminently distinguished. Several water salamanders have, of late, been described by different authors, under various other names. The cause of the mistake seems to be, that the animals were immature, not having dropped the deciduous organs. Under this description may perhaps be classed the following animals, which are believed to be,

WATER SALAMANDERS NOT FULLY EVOLVED.

Sirène operculée, *Palisot de Bauvois*,
Am. Phil. Society's Transactions, vol. 4.
Quadruped Siren of *Barton*. (CUVIER.)
Proteus Neo-Cæsariensis of *Prof. Green.*
Jour. Acad. Nat. Sci. Philadelphia, vol. 1, p. 407.

Several other reptils have been supposed to belong here, which are now described as mature animals, for reasons given under the genus Proteus.

REMARKABLE SPECIES.

The species of this genus are very numerous in our country; so much so that it may be called the native region of Salamanders. If time and circumstances permit, a monograph of this genus may be expected hereafter. In the mean time the following remarks are submitted to the scientific readers of this Journal,* on the very remarkable species discovered and described by Professor Savi, of Pisa, and by him denominated,

SALAMANDRA PERSPICILLATA.

Bibliotica Italiana No. 65. (*Rev. Encyc.*)

This very singular animal is preserved in the Cabinet of the Lyceum, having been kindly sent by the discoverer. It is not a salamander, as that genus is limited in this paper, for it has four toes on the hind feet, ("*palmis plantisque tetradactylis,*") contrary to the analogy of all the five preceding genera. But this is not all. It has knotty or spi-

* See vol. 5, page 174.

nous protuberances on all sides of the tail, showing a resemblance, distant indeed, to the Stellios; and small scales on the body, and a chain-like process down the back: in all, such an approach to being *armed*, that it can hardly be denominated *naked*. The general appearance of the animal is like that of the salamanders. Body slender, tail long, tongue and teeth like those of the salamander; top of the head with an irregular white spot; back dark brown; belly white, with dark brown or black spots: under jaw white; *scales very minute;* a chain-like process down the spine, and on the tail, which is also furnished with elevated knotty protuberances on all its sides; head broad; toes four before, four behind. Length three inches, tail half. I should think that it might have been made a separate genus. If the characters of the specimens generally are consonant to this specimen, the animal *ought* to be called by a new generic name. It might be called SEIRANOTA, from the *chain-work* on the *back*, and CONDYLURA, from its *knotted tail. Seiranota condylura*, or, reserving Savi's specific name, though an unhappy one, because it is indistinct, *Seiranōta perspicillata.* Knotty-tailed chain-back. Inhabits the Appenines of Tuscany, and especially at Mugello. *Dr. Paulo Savi.*

SECOND DIVISION.—NOSTRILS AND SPIRACLES.

* * * *Branchial opercula and tail persistent.*

6 GENUS.—MENOPOMA. *Harlan.*

Legs four, short and strong.
Toes four before, five behind, all without claws.
Teeth, two rows above, and one below.

Figure. Annals of the Lyceum, pl. 17th, vol. 1.
Synonyms. Protonopsis horrida. *Barton, (Le Conte.)*
Salamandra horrida. *Barton.*
Salamandra gigantea or maxima. *Barton.*
Salamandra Alleganiensis. *Michaux.*
Salamandra des Monts Alleganiens. *Sonnini and Latreille.*
Abranchus Alleghaniensis. Annals, 1. 233.
Menopoma Alleghaniensis. Annals, 1. 271.
Molge gigantea. Merrem.

Hell-bender. Mud-devil. Ground-puppy. Tweeg. Young Alligator. Vulgo.

Erroneously supposed to be the same as the Proteus of the Lakes, by *Dr. Mitchill.* And also by *Cuvier*, in his late work on Fossil bones.

The Triton Alleghaniensis by Daudin.

The Triton Lateralis by Say, (Notes on Prof. Green's paper.) that is, the T. Lateralis is supposed to be the young of this animal. They have been shown by Harlan to be distinct.

DESCRIPTION AND HABITS.

This animal is remarkably thick and chubbed. Legs short and strong, with the two outer toes of the hind feet palmated, and the outer edge of the feet fimbriated. Head broad; nostrils prominent; mouth wide; body slate colored, with dark spots, and a dark line passing through the eyes; tail vertically compressed and nearly as long as the body. By having the spiracles covered with a simple flap, this animal is distinguished from all others of the family, except the *Amphiuma*; and from this, by having a greater number of toes. The number of toes will always distinguish this animal from the *Proteus* of the same waters, with which it has so very often been confounded that it is nearly impossible for any person to distinguish them by what is found in the books. Even the ablest naturalists have been misled, and until the publication of Dr. Harlan's paper, these two animals were very generally supposed to be the same. One reason of the mistakes so often made is that, though frequently seen, the Menopoma is seldom taken; on account of the terrible aversion that prevails among fishermen against an animal of an uncouth and revolting figure, to which they have given an approbrious name, and which they believe to be poisonous. The *Menopoma* always resides in the water, eats flesh, is very voracious, sparing nothing which he can devour. He inhabits the Ohio and Alleghany rivers, and grows to the length of two feet or more.

7 GENUS.—AMPHIUMA. *Garden. Linn.*

Legs four, slender and boneless.

Toes, two before and two behind, without joints or claws.

Teeth, two rows above and one below.

Figures. Annals of the Lyceum, vol. 1. pl. 22.
Journal of the Academy of N.S. vol. 3. page 58.

Synonyms. Chrysodonta Larvæformis. *Mitchill.* Medical Recorder, No. 19.
Amphiuma means. *Linn. Garden.*
Quadruped Siren. *Barton? (Cuvier.)*
Congo snake. *Vulgo.*

DESCRIPTION AND HABITS.

Head rather long, tapering, depressed, serpentlike; mouth extending half the length of the lower jaw; a single row of teeth in the lower, and two rows in the upper jaw. The points of the *teeth* are somewhat flattened, and turned backward, reflecting the *golden* rays.* The teeth, of the outer row of the upper jaw, are *attached* to the inner surface of the jaw, and not *inserted*. The inner row divides the roof of the mouth into three nearly equal parts, making four ranges or files counting across the jaw. This is *perhaps* what Garden meant by saying that it had *four rows* of teeth in the upper jaw. The upper lip covers the under one, and has the nostrils at its extremity. The general appearance of the animal is serpentlike. The legs are very small and placed very far asunder. They have no proper bones, or feet; and having only a simple division of the extremity without claws, or even proper toes, they would seem to be of very little use in the economy of this singular animal. It is found in the southern states, particularly those bordering on the Gulf of Mexico. It lives in ditches and stagnant waters. It burrows in the mud, passes the season of Hybernation below the reach of frost. It can live on land. It grows to the length of more than three feet. Its color is a dark brown, with a bluish tinge on the sides, and the belly rather lighter. Several specimens are preserved in Dr. Mitchill's Cabinet, also in the Philadelphia Museum, under the name of "Amphiuma Means. *Garden.*"

Remarks. The two genera of animals last named, agree in having openings through the sides of the neck, somewhat resembling the gills of fishes. These openings are called *spiracles*, tho the use of them, in the animal economy, is not well understood. The spiracles are covered by a simple smooth-edged flap, or operculum. The Amphiuma is the animal that a German traveller, cited by Rusconi, saw in London, and pronounced to be a four-legged Siren, thence af-

* Hence the name given by Dr. Mitchill, from χρυσον et οδους.

firming that the Siren was only a larva. Cuvier has answered this objection, in his late work on Fossil bones.

* * * * *Branchiæ and tail persistent.*

(a) *Opercula subdivided.*

8 GENUS.—SIREN. *Linn.*

Body long and serpentine.
Legs two, anterior.

§ *Divisions of the opercula simple.*

SPECIES.—SIREN STRIATA. *Le Conte.*

Toes three, without claws.
Teeth, none in the jaws. Teeth in the palate?
Figure. Annals of the Lyceum, vol. 1. pl. 4.
Synonyms. Pseudobranchus. *Gray.* Guana. *Vulgo.*

DESCRIPTION AND HABITS.

Color dusky, with a broad brown stripe on each side, and another paler one on each side of the belly; beneath, speckled with brownish white; tail compressed, ancipital; sides marked with transverse furrows; spiracles, three on each side, with a fleshy trilobate covering; the lobes entire and naked; body covered with a thick mucus. It inhabits the mud of swamps, and does not burrow in the ground. It is perfectly mute, swims with tolerable agility, but can make little if any progress on land. When taken out of the water it soon expires. It is rarely found. It grows to the length of nine inches, and is proved to be mature by being found full of spawn. It has been compared with the young of the Siren Lacertina of the same length, and found to differ permanently from that species. The S. Lacertina retaining its characteristic marks from youth to age, cannot be confounded with the present species. Both specimens are preserved in the Cabinet of the Lyceum, the gift of Captain Le Conte, who discovered and described the present species, and from whose paper this description is principally taken.*

§ § *Divisions of the opercula compound.*

SPECIES.—SIREN. LACERTINA. *Linn.*

Toes, four,† cartilaginous rather than horny, at the point.‡

* See Note at page 269.
† Cuv. Reg. An. says *five*.
‡ See extract from Cuvier, under the genus Pipa.

Teeth, none in the jaws; in the palate, numerous, disposed in oblong plats on each side.

Figures. Linne's Dis. on the Siren, fig. c. (Upsal, 1766.)
Stewart's Elements of Natural History, pl. 5, fig. 4.*
Brewster's Encyclopedia, pl. 298, fig. 24.
Shaw's Zoology Amph. pl. 138.
Rees's Cyclopedia, art. amphibia, pl. 6, fig. 1.

Note. This figure has too fierce an aspect for so harmless an animal.

Synonyms. Muræna Siren. *Gm. Linn. Turton's Linn.*
Muræna Siren. *Stewart's Elements.*
Mud Iguana. *Ellis.* Phil. trans. vol. vi. 189.

DESCRIPTION AND HABITS.

"Body black above, dusky beneath, speckled with yellowish; or above dusky, beneath paler, speckled every where with yellowish; eyes small, bluish; nostrils placed near the edge of the upper lip, small, distant; jaws toothless, furnished with a hard black skin. Spiracles, three on each side, near the neck, linear; the interior edge serrate, with a fringed trilobate covering; tail compressed, with a narrow rayless fin above and below." (Le Conte.) Tongue free; sides marked with transverse furrows, imitating ribs.† It inhabits the muddy swamps of South Carolina, and, like the *Siren Striata* and the *Amphiuma*, has not been found in any other region. It lives principally "in the firm and moist clay" or thick mud, and is, at times, also found in the water. A fine specimen in Scudder's museum has already lived several years in a glass jar of clear water, and others an equal length of time in a tub brought from Carolina and presented to Dr. Mitchill. These last, when taken from the mud, immediately struggle to return, and seem contented only when they are in their native element. It is remarked that when these Sirens are themselves concealed in their retreat, the place of the head and gills is immediately known, by the rising of small air bubbles from their spiracles. This fact may lead to the determination of the question concerning the function of these doubtful organs. Several respectable naturalists have published descriptions of Sirens having "*four* branchiæ, a double row of teeth in each jaw," and of their "feeding on serpents, which they hold with their firm and strong teeth;" but these descriptions are so different from any thing at present known, that we must con-

* Several of these figures appear to be copies of one original.

† This appears to be the case with all the tailed Batracians, from the Salamander to the Proteus.

clude that their authors were greatly misinformed, or that there is yet *another species* of Siren, unknown to the modern naturalists, from which Linne wrote his description.

The name *Siren* is applied to this animal on account of its "vox cantillans," in allusion to the Greek fable, as related in the Odyssee of Homer, Book 12th. Several authors affirm that Sirens thrown on the ground break into several pieces. The want, or the high value of specimens among us, will probably prevent this fact from being proved or disproved by actual experiment. To me, however, it seems improbable; as the animal is lithe and agil, and the bones are firm.

It may be useful to know in what state Linne left the history of this animal, which has caused so much doubt and disputation since his time: therefore, as the book has become very scarce, I extract the description entire. On page 371 of the 12th Edition, in a note at the bottom, he expresses a doubt in these words.

"Siren lacertina an Larva Lacerta? conf. diss. nostr. de Sirene, 1766."

At the end of the 1st volume, under the head of addenda, he says,

(395. ad finem paginæ adde.)

MEANTES.

Branchiæ et pulmones simul.
Pedes brachiati, unguiculati.

SIREN. Corpus bipedum, caudatum, nudum.
Pedes brachiati, unguiculati.

Lacertina. 1. SIREN, de qua pag. 371. lin. ult. & Dissert. Siren. Upsal. 1776. c. fig.

Habitat in Carolinæ paludosis, D. D. Garden inventor. Dubius hæsi, utrum hæc esset Larva Lacertæ cujusdam, quam potissimum refert; an declaratum animal? hoc suadent Manus unguiculatæ & vox cantillans, at ulterius hoc urget inventor speciminibus sesquipedalibus missis, cum in totâ Carolinâ nulla sit Lacerta, excepto Crocodylo, ultra spithamum longa.

This appears to be the amount of the knowledge possessed by Linne, and of this even, a part is doubtful; for it does not appear, by the most careful observations of the modern naturalists, that the animal has a "vox cantillans." The idea which produced the generic name is therefore imaginary.

(b) *Opercula fimbriated.*

9 GENUS.—PROTEUS. *Laurenti.*

Legs four. Toes clawless.

Teeth in both jaws, small and numerous.

Body lengthened, terminated by a vertically compressed tail.

SPECIES.

1. PROTEUS ANGUINUS. *Proteus of Carniola.*

Toes, three before and two behind.

Teeth, one row above and one below.

Spiracles, three on each side.

Length, thirteen inches, bredth one inch.

Figures. Humboldt's Voyage. Configliachi. Brewster's Encyc. pl. 298, fig. 23. Daud. 99, fig. 1. Rees's Cyclopedia, art. Amphibia, pl. 6, fig. 2.

Synonyms. Proteus anguinus. *Laurenti, Schneider, et aliorum.*

Siren anguina. *Shaw's* Gen. Zool. III. p. 608.

Hypocthon Laurentii. *Merrem.* Sys. Amp. p. 188.

Serpentine Proteus. Anguine Siren. *Anglorum.*

Le Protee anguillard. *Daudin.*

DESCRIPTION.

Body long and slender, terminated by a vertically compressed tail, forming a fin, and rounded at the end; tongue short, thick, adhering within to the lower jaw, but free at the point. Head somewhat flattened; nose lengthened, obtuse and broad. Fore legs close to the gills, and about three-fourths of an inch long. Hind legs far back. Skin smooth and even. Sides wrinkled transversely. Color pale rose or flesh red, sometimes nearly white. The three pair of ramified branchial fins of a bright red or scarlet color. Nostrils small; eyes very minute, black, and concealed under the integuments. Ear concealed by the skin, as in the Salamanders. Its motions, when out of the water, are slow and languid. In its native element it swims with tolerable agility, waving its body in a serpentine direction, like a leech. It undergoes three metamorphoses.* In the two former it is blind and without feet.† Its note resembles the sound made

* Hence its name, from the multiversant sea-god.

† Brewster's Encyc.

by forcing down the piston of a syringe. The skeleton shows a general resemblance to that of the Salamanders. The vertebers are more, and the false ribs less in number. The greatest difference is in the general shape of the strong and bony scull. The Proteus anguinus inhabits the Lake Sittich, which communicates with the Lake Zirknitz, in Carniola, from which the water retires in summer and returns in October, through many under ground passages, which are the proper abode of the Proteus. It is a feeble and subterraneous animal, of a pale color, for want of exposure to the light. When exposed, it gradually changes to a darker color. The Proteus never comes out of his subterranean retreat, except at the inundations. It is said to crawl up on the rocks of the caverns, but for what purpose we are not informed. It has lately been discovered in the Grotto of Adelsberg, on the great road from Triest to Vienna. A specimen, accompanied with a beautiful wax cast, was received from the imperial cabinet at Vienna, through the *Baron Von Lederer*, and is preserved in the Cabinet of the Lyceum.

The Proteus anguinus, for a long time after its discovery, was disregarded, or believed to be an immature animal. The labors of *Schreibers* have fully elucidated the subject, and this Proteus is now every where admitted into the systems, as a perfect animal, tho it is difficult fully to understand its organization. It was first described by Laurenti, in 1768. He included in his genus the AXOLOTL, which, after all the doubt and disputation on this subject, will probably prove to be the simplest and best mode of arranging these animals.

2. PROTEUS LATERALIS.—*Proteus of the Lakes.*

Toes, four anterior, and four posterior, without claws.

Teeth, 2 rows above } small, sharp, and attached to the
" 1 row below } inner surface of the jaw.

Figures. American Journal of Science and Arts, vol. vii. pl. 2. *(colored.)*

Annals of the Lyceum, vol. i. pl. 16. *(melior.)*

Figured also by Milbert, as quoted by Cuvier, in his late work on Fossil bones.

Synonyms. Proteus of the Lakes. *Dr. Mitchill.* A. J. S. vol. vii. page 63, et seq.

Salamandra Alleghaniensis (young.) *Say** ?

Triton Alleghaniensis (young.) *Daudin* ?

Siren of Barton ! as quoted by *Say* and *Gray*.

* See page 279. 2d paragraph.

Triton Lateralis. *Say*. Long's Expedition, 1 vol. 5 p.
Menobranchus Lateralis. *Harlan*.
Proteus of the Alleghany river. Dr. Mitchill. A. J. S. ut supra.
Siren Lacertina. Schneider. H. Amph. 48.

DESCRIPTION.

This Proteus grows to the length of two feet. (MAJOR DELAFIELD.) Body smooth and without scales, slimy, soft, spotted with black, and pervious with many pores. Tail compressed and ancipital, lanceolate, spotted on both sides. Head broad, flat and fleshy, truncate or sub-emarginate before. Eyes small. Nostrils minute, placed in the margin of the upper lip. Nose broad and depressed, lips flabby and covering the jaws. Tongue broad, entire, free at the point, one fourth of an inch. Teeth conic, obtuse, small, rather distant, those in the upper jaw less. Mouth opening to the vertical line of the eyes. Throat with a duplicature of skin beneath. Anal fissure longitudinal. Three ramified and fringed branchiæ opposed to *two* branchial apertures, which are furnished with cartilaginous tubercles as in fishes; the upper and lower arch of the branchiæ adnate to the skin. In the Proteus from the Alleghany River there is a black stripe from the nostrils, passing over the eyes and disappearing behind; but this mark is not found in the Proteus from the Lakes. They are, however, of the same species, differing slightly in color. This Proteus inhabits all the great Lakes. It is frequently caught at the falls of Onion River, about one mile and a half from Burlington, Vt. The most favorable season is in the spring, when the water is cold. With hooks attached to set lines, five or six are sometimes caught in a night, though not at all desired by the fishermen; for they are universally beheld with abhorrence; and scarcely ever touched by the hand, even to disengage them from the hooks. When they happen to be inclosed in the nets among fishes, they are carefully buried as poisonous; and when they take the hook, they are sometimes beaten and sometimes burned to death, before they are detached, by cutting their mouths with a pen knife. It seems that the most favorable situation, for the capture of them, is at the lowest falls of small streams running into the Lakes; such as Onion River and the outlet of Lake George. In the Western Lakes they may be taken with the spear, if the fishermen can be persuaded to strike them; but to this they are generally very much averse. Several specimens were found in the Erie Canal when the

end opening into the Lake was accidentally drained during the present summer, (1825.)

I have received probable information of another "water lizard," which inhabits Lake Champlain, and has been caught at the lower falls of Ticonderoga by fishing, with a hook, at night. The animal is described to me as black, long and slender, with four legs and a tail. It is said to be one foot and a half long, and without the spots by which the Proteus is remarkably distinguished.

Remarks. The first *specific* name given to this Proteus appears to be that of Mr. Say, who called it *lateralis*, in allusion to the black *lateral* line. The discoveries already made, or made rather before Mr. Say's description was published, show that the character from which he derived his name is variable, for it is not found in the Proteus of the Lakes, which, in the same paper, he asserts to be the same animal. The genus to which Mr. Say assigns this reptil, is omitted by most of the modern naturalists, and the honor of naming it seems of right to belong to the man who first had the sagacity to discover its true affinities to the Proteus anguinus of Carniola. The Proteus lateralis differs from the Proteus anguinus by having fewer dorsal vertebers, and a greater number of false ribs. Cuvier makes the same remark and comparison between the Proteus anguinus and Salamanders, as is here made between these two animals. The Salamanders, in fact, in this respect, compare pretty exactly with the Proteus Lateralis, and the Proteus Mexicanus, or the Axolotl. I do not perceive any good reason for making a new genus to receive this animal. Dr. Mitchill describes him as a Proteus. He is without doubt very closely allied, and yet perfectly distinct from the Axolotl. A careful examination of the two animals together has been made, and the result is entirely satisfactory. Laurenti, the founder of the Genus Proteus, included in it the Axolotl, and both Cuvier and Lacepede have called the Mexican reptil a Proteus. Against this the reason alledged is that the number of dorsal vertebers in the American animal is greatly inferior to the same in the Austrian animal; and that the rudiments of ribs are an entire series, and also "somewhat larger and longer in the former than in the latter." The number of vertebers is not admitted by Dr. Harlan as a generic distinction in the water Salamanders, (Annals of Lyceum 1: 229,) why then should it be insisted on here? That author allows a

difference of *fifteen* in this very animal, when the whole, and not the dorsal vertebers only, are enumerated. His words are, " from twenty to thirty-five." (Long's Ex. 1 vol. 7th page.) How then can the reason *exclude* a GENUS, which *includes* a SPECIES? Is it not saying that a part is greater than the whole? that the greater does not include the less? Again, the same author tells us that " the number of *vertebræ* and *ribs*, in the aquatic Salamandræ, appears to differ in *different species*." Surely then may not the number be permitted to differ in the *same genus*? If not, then there must be more genera than species. But it may be answered that we permit the *caudal* vertebers to differ, and insist on the *dorsal* vertebers being the same. This answer cannot be satisfactory. For, besides the very remarkable instance of the two *species* of Sloth, viz. the Bradypus tridactylus, with nine cervical vertebers, and the Bradypus didactylus with seven, in which the discrepance of the former, not only with its congeneric species, but also with the whole class of the Mammalia, is not allowed to form a separate genus; the number of *dorsal* vertebers and ribs differs in the Proteus anguinus itself. Marten says the number of dorsal vertebers is *thirty-one;* Harlan says *thirty*. Schreibers, after dissecting more than one hundred, says that the number varies from *twenty-six* to *twenty-eight*, and that the number of false ribs also varies, and that in some specimens there were *no ribs at all.*

Either Dr. Harlan's concession, or this statement of Schreibers, is more than sufficient to class the animal in question in the same genus with the Proteus of Carniola. Can it be asserted that *any genus*, nay, any *species* of vertebrated animals has always and uniformly the same number of joints in the back bone? Has not Dr. Harlan found, even in the human subject itself, an occasional difference in this particular? But what is the amount of this difference, so much insisted on as to induce the author to say that the animal, described by Dr. Mitchill, " has, in reality, no affinity to the Proteus?" The dorsal vertebers of the Proteus, according to Schreibers, are 26 or 28. The same bones of the Proteus of the Lakes are 19, and the whole difference between them is 7 or 9.

The whole number of the vertebers in the P. Anguinus is 56. The whole number of the same bones in the P. Late-

ralis is 54, both according to Dr. Harlan, and the difference is 2.

If a difference of two in the *neck* of the sloth, and that, contrary to the analogy of the whole class, is not allowed to constitute a different genus, why should a difference of seven or nine, or even eleven, in the *back* of a Proteus, constitute a different genus? If the *tail* of the *same* species may differ *fifteen*, I see no reason why the *back* of *different* species may not differ *nine*. Allow but this, and our animal comes out triumphantly a Proteus. And such, beyond all doubt, he is. If in any case genera are of use, that use will be found here, in grouping together animals that resemble each other in the following particulars.

1. Body long, lacertine and scaleless.
2. Tail vertically compressed, forming a fin.
3. Four feet with clawless toes.
4. Interior lungs like frogs?
5. Exterior gills like fishes.
6. Three pairs of compound, ramified, fimbriated branchiæ.
7. These very remarkable appendages persistent through life.
8. Cartilaginous arches, and membranous opercula.
9. Nose elongated, depressed, and very obtuse before.
10. Jaws furnished with teeth.
11. Tongue free at the point only.
12. Eyes very small, and nearly concealed by the skin.
13. Ears covered by the common integuments.
14. Nostrils at the extremity of the upper lip.
15. The remarkably flattened and bony scull.*
16. The habitation in water, and the meandering motion of the body.
17. The habit of occasionally emerging from the water, and climbing the bank or shore.
18. The general similarity of the skeleton to that of a water salamander, in the vertebers and false ribs.
19. Body marked with transverse furrows, imitating ribs.
20. The peculiar form and structure of the branchiæ.

In all these particulars the two animals agree, and these particulars are all and more than all those by which Cuvier *describes* the Proteus in his Regné animal. Omitting all

* See Cuvier on the scull of the Proteus.

other points of resemblance, the peculiar form and structure of the branchiæ is abundantly sufficient to show a strong "affinity." There are, perhaps, but four animals, in the world, that have the like; and in these the branchiæ are so remarkably similar that the language used to describe one, must almost necessarily be used to describe the other. If the above mentioned similarities will not comprise these animals within the same genus, it will be difficult to show any thing that in any case can be called generic, or in other words to define a genus.

The difference between the Austrian and the American animals shall also be fairly stated, for truth is our object.

The P. Anguinus is a long and slender animal, of a pale and delicate color.

The P. Lateralis is shorter, more robust, and of a dark, hardy color.

The toes of the former are three and two.

The toes of the latter are four and four.

The pelvis of the former is attached to the 26th or 28th joint of the back bone.

The pelvis of the latter is attached to the 19th joint.

Now give to these differences their full weight in our consideration, and to what do they amount? The American animal is doubtless more robust than the European. He needs a stronger body, inasmuch as the waters of the Alleghany River and the great Lakes are more turbid and tumultuous than the unruffled waters of the subterranean caverns of Carniola; for it should be remembered that it is only an accidental cause that ever brings the P. Anguinus out to the light of day.* Cuvier says that the number of the toes ought to form only a specific character. All that remains then, is the difference in the dorsal vertebers and the false ribs, on which the advocates for the new genus can depend. As to the ribs, they differ so greatly in the P. anguinus itself, that no fair argument can be thence derived; and the hind legs being attached nearer or farther from the fore ones, may, without impropriety, be considered as merely a specific distinction. I would speak, with all possible kindness, of the gentlemen who differ from me. I sincerely esteem them and prize their friendship, nor can I conceive that the publication of different opinions should be a cause of of-

* Hence Merrem's name, Hypocthon, from ὑπο under and χθων the ground.

fense to any one, provided that the tone is mild and the language courteous. I have, however, been struck with some surprize that the two gentlemen who so very particularly undertook to dissect the Triton Lateralis, and publish an account of its Osteology, should so very carefully abstain from all mention of the *scull;* and that one of the same gentlemen, republishing the same animal, with a new name, should make the same very important omission. Is not the scull an organ of equal importance with the false ribs? And is there not a striking resemblance between the sculls of the American and the Austrian animal? I fear that some things, said and repeated in the "Annals of the Lyceum," concerning the scull of the Proteus, were not the deductions of a rigid examination. When I began this paper, I attempted to arrange these animals according to the method suggested by *Captain Le Conte,* and repeated by *Dr. Harlan,* that is, by those that have solid sculls, and those that have sculls composed of many pieces. However, after a full conversation with the gentleman who made the suggestion, and after dissecting several specimens, and examining the published accounts, I was compelled to admit the conclusion that there is not in that suggestion a sufficient degree of truth and fidelity to nature to admit of its adoption. I am not sure that I understand the gentlemen in what they say of solid sculls. I have sought information from men of distinguished eminence, and the result is a conviction that, if I do understand them, they are wrong. But if there is that striking difference between the scull of a Proteus and the Triton Lateralis, why was it not mentioned when the effort was made to show that the animal which Dr. Mitchill had called a Proteus was not a Proteus? Either these sculls are similar, or they are not. If they are similar, they may characterize the same genus, if not, they still may discriminate different species. The fact is, they are remarkably similar, otherwise they would have formed a more plausible topic than the false ribs, and the dorsal vertebers.

3. PROTEUS TETRADACTYLUS. *Lacepede's Proteus.*

Toes, four before and four behind.

Teeth, two rows above and two below.

Length 6.4 (French) inches. Length of the head, from the tip of the nose to the end of the gills, 1.1 inch. Tail 2.4. Legs, each being of the same length, .55.

Figure. Annals of the Museum, vol. x. p. 230.

DESCRIPTION.

Head much flattened, particularly below; nose a little rounded; upper jaw projecting a little beyond the lower; two rows of very small teeth above and below; tongue very short, flat and rounded. A fold of skin under the neck, resembling a collar, extends laterally to the upper side of the gills. Eyes visible, tho covered by the epidermis and partially concealed. Nostrils placed rather distant, on the extremity of the nose. Three branchiæ on each side of the neck, large, and furnished with tufted fringes; tail laterally compressed, and furnished above and below with a thin membrane, which makes it appear more compressed. Skin without scales, but viscous, and wrinkled transversely, like that of most Salamanders and Cecilias. A longitudinal furrow runs over the head, from the nose to the commencement of the tail. A similar furrow beneath the body, from the fore to the hind legs. The tail performs the office of a tail-fin, as in fishes. Habitat unknown.

Remarks. The above is the description of the Count Lacepede, translated from the "Annals of the Museum." I should conjecture that this animal came from North America, the native country of all the doubtful reptils, except the Proteus anguinus, and the country which will probably furnish hereafter several others of the same family.* The difference between this and the Proteus of the Lakes, appears to consist in the additional row of teeth in the lower jaw, and the (spatulate) tail broader towards the extremity, and the fold of skin under the neck. Lacepede calls it a Proteus, and thinks that the Axolotl should also be so called, and that they should be arranged thus:

Proteus	Anguinus,	Toes 3—2
P.	Tetradactylus,	Toes 4—4
P.	Mexicanus,	Toes 4—5

In this opinion I most cordially concur, and I insert the Proteus Lateralis in the second place, which, I doubt not, the learned author would have done, had he known the animal. Dr. Mitchill's Proteus and Lacepede's mutually confirm each other, and elucidate the general view here taken of these very interesting reptils.

Remark. No mention is made of the color of this animal, and some persons have doubted its maturity, and others

* See note at page 269.

its difference from the Lake Proteus. That it is both mature and different, its two rows of teeth appear to prove conclusively.

4. Proteus Mexicanus. *Mexican Proteus. Axolotl.*

Toes, four before and five behind.
Teeth, one row above, and one row below.

Figures. Shaw's Zoology, vol. iii. part 2. pl. 140.
Humboldt's Voyage.

Synonyms. Axolotl, or Ajolata, (pronounced Aholota) *of the Mexicans.*

Axolote Mexicaine. *Cuvier.* Proteus, *ejusdem.*
Siren Pisciformis. *Shaw.*
Proteus Mexicanus. *Green.*
Proteus Mexicanus. *Brewster's Encyclopedia.*
Tetard mangeable. *Hernandez. (Humboldt's Voyage.)*
Atolocatl of Hernandez, as quoted by *Cuvier.*

DESCRIPTION.

Head flat and large, broader than the body; nose rounded; eye small and round, and placed far forward; body stout and large, swelled in the middle, broader in proportion to its length than that of other reptils. Tongue large, smooth, rounded at the point with very little freedom, and that only at the point. No apparent neck. The mouth opens to the eyes, one fourth the length of the head, but when shut, the rectus appears larger than it really is, on account of a lateral sulcus which procedes from each corner of the mouth to some distance backward. Nostrils at the point of the nose. Teeth, a single row in each jaw, and teeth in the sides of the mouth, all very small. A thin crest or elevated fin runs from the shoulders, down the body, to the tail, and on the under side to the vent. This crest is highest in the middle of the tail. Gill-openings four, much larger than those of the Siren; four semicircular cartilaginous arches, as in fishes, of which the two middle ones have two rows of serratures; the other have one. A fold of the skin of the head forms an operculum which covers the whole four openings. These opercula are very large, and continued under the throat so as to insulate the whole head. They are furnished on the exterior with three very large elegant branchiæ, ramified into a vast number of capillary processes, or long hairs. The fourth arch has none. These branchiæ

are as long as the legs of the animal, the upper one being largest and the lowest one least. The color is a deep brown, or ash gray, with numerous rounded blackish spots, and a vast number of very minute white points, invisible to the naked eye, scattered over the whole. The skin is smooth, without scales, and the sides are impressed with a number of strong wrinkles, or transverse furrows, and a lateral sulcus is continued from the gills to the tail. This Proteus inhabits the Lake Tezcuco, that surrounds Mexico; and is found also in the mountain Lakes, and cold waters of the same region. Remarks. Cuvier is fully of the opinion that the Axolotl is the larva of a large Salamander, and in that opinion Dr. Harlan coincides. Lacepede is, however, of the opinion that the animal is a Proteus, and that it should be arranged next to his Proteus Tetradactylus, because it has *five* toes on the hind feet. This, as before observed, would certainly make a very intelligible distribution of these animals, and altho the osteology may perhaps differ a little, yet it seems the most eligible mode of arrangement hitherto proposed. The Axolotl, I should think, carried his gills permanently; if so, he cannot be called a Salamander, but ought to be denominated, as by several respectable authors he has already been called, a Proteus. Why should they insist on the axolotl as a larva? Because its bones are soft, and its claws cartilaginous. The former of these may show juvenility in the animals that have hard bones, but if the bones should be somewhat similar to those of the cartilaginous fishes, no argument could be thence deduced. The animals examined by Cuvier were both young ones, and of course they must have had bones less solid than adult specimens; so that from this circumstance no sound conclusion can be drawn in either way; and as to the claws, such is their nature that it is difficult, as before mentioned, to determin whether several of the related genera have *nails* or not. Two persons deliberately examining the Siren, now in the Museum, at the same time, pronounced directly opposite opinions as to the fact before them. The scull is broader and the eye smaller than those of the Salamanders. The atlas is articulated by two condyls, as in the Siren, and the support of the branchiæ are similar, and " that an apparatus so complex as that of the branchiæ, their arches, and the muscles that move them, should disappear without leaving a

trace,"* might well be thought very extraordinary, if not incredible. Has the Axolotl ever been seen without its branchiæ? If it had, there would not be any doubt. Is there any instance in which the economy of nature is so profusely misapplied, as to furnish so large, long and *elaborate* organs, for a mere temporary purpose?† The Axolotl is a large animal, 10 or 12 inches long. If a mere larva, the perfect animal must be of a formidable size. Such an animal, with four legs and a tail, could not have been concealed and unnoticed all the time that Humboldt, Bonpland, and other travellers, were in the neighborhood of Mexico.

Cuvier says, "the more I have examined these animals, the more I am convinced that they are the larva of some great Salamander, yet unknown." I venture to predict that such a Salamander will for a long while remain unknown; and that whenever and wherever the Axolotl shall be found, he will have his large compound ramified gills, to show his natural affinity to the Proteus of the Lakes and the Proteus of Carniola. The former of these animals, tho abundantly proved to be adult in this country, is still unacknowledged as mature, in Europe; and Cuvier, in his latest publication,‡ says that it is a larva. It is possible, and I think it probable, that Cuvier may change his opinion when he shall see the Menobranchus of Dr. Harlan, (Proteus Lateralis,) as he did when he saw what he erroneously supposed to be the figure of the Menopoma. (Salamandra Alleghaniensis.) As yet, he is evidently under a mistake; for he says that "the cicatrices which are seen on the great Salamander," (Menopoma,) "fully prove that it carries its branchiæ a long time," whereas Dr. Harlan has fully shown that it never has any branchiæ, even in its youngest state. Cuvier has acknowledged his mistake in supposing that the Axolotl was the larva of the Salamandra Alleghaniensis, (the Menopoma,) but in doing this he has fallen into another mistake, which is, that the animal figured by *Milbert*, while in the possession of *Dr. Mitchill*, was the larva of the Salamandra Alleghaniensis. This animal was brought from Lake St. Clair, by *Maj. Delafield*, who has since obtained several others from Lake Erie. It is the Proteus Lateralis of this paper, Triton Lateralis of Say, and Menobranchus Lateralis of Dr. Har-

* Cuvier.

† The case of the Surinam frog cannot be considered analogous. The deciduous part is simply *large* and fleshy.

‡ Ossemen's Fossiles, seventh and last volume.

lan. The two animals are greatly and permanently different. One always *with* the branchiæ, the other always *without* them; one always with *four* toes behind, the other always with *five;* and other differences may be seen by a reference to Dr. Harlan's paper, in the "Annals" before quoted.

The European Naturalists are very cautious concerning these American animals. Perhaps they are not too much so; and yet they are compelled, step by step, to yield the ground, first to the *Siren*, as a perfect animal, then to the *Amphiuma*. Next, without doubt, will be to the *Menopoma*, and the *Proteus*, all of which, *and perhaps others*, will be found to be mature and perfect animals. The authority of Cuvier is perhaps equal to that of any man, and yet he is, like other men, liable to mistake; as for instance, when he tells us, in his *Regne animal*, that the Siren Lacertina has *five toes;* and also in the cases above mentioned. "No larva has teeth," says Capt. Le Conte, and on making the discovery of the formidable array of teeth in the Proteus Lateralis, he immediately gave up his opinion of its being an immature animal. Such, I am persuaded, will be the case with the Axolotl, for it also has numerous teeth. Cuvier supposed that Schneider's animal was a larva, but it is not. He supposed that Dr. Mitchill's Proteus was a larva, but it is not. The great Linné supposed that the Proteus anguinus, sent to him by Scopoli, was a larva, but it is not. The Italian naturalists insist, even yet, on the Siren as immature, but it is not; and I am fully persuaded that the Proteus Mexicanus will vindicate his claim to a separate and conspicuous station in the catalogue of American Reptils.

Several obscure indications, not yet sufficiently authenticated to be adopted, render it probable that *other species* of this family of reptils will hereafter be discovered. Such animals are now in the state that Schneider's animal was, until again found and described by Dr. Mitchill, and the full establishment of the facts concerning the two animals of our country, renders it probable that others will yet be ascertained which are at present doubtful.

Since the preceding part of this paper was written, the AXOLOTL has been brought to this city, (New-York.) Three specimens, finely preserved, in sealed tin cases, were received by Dr. Dekay from Dr. Woodbury, of Mexico.

They fully confirm the general views of the foregoing descriptions. They exhibit no appearance of immaturity, and no one who has seen and examined them, can, for a moment, believe them to be Salamanders. If mature, as they appear to be, and of this we have not the least possible doubt, they at once settle the question on which so much has been written, and which has been so much doubted. They are nearly allied to the Lake Proteus, and yet perfectly distinct. Dr. Harlan seems to think that they "have every characteristic of Salamanders." I, on the contrary, think them unlike in important parts, and essential particulars, and I have very little doubt that naturalists generally will acknowledge the propriety of the foregoing views, as soon as they shall have the opportunity of particularly examining the several species here enumerated.

The singular and compound structure of the respiratory organs has been a fruitful source of doubt and disputation. The truth at last seems to be, that the air is inspired by the nostrils into the air sacks, and reserved for use while the animal is in the mud, or under the water, and slowly expired by the gills or spiracles. The lining membrane of the mouth closes the posterior *nares*, and prevents the escape of the air, and the persistent operculum closes the opening of the gills, and prevents the influx of the water. The fringed gills may be useful in keeping a free space around the opening, so that the animal may not be strangled by lateral pressure. They may also, in the water, perform an office similar to that of *mastaces* or tentacula in other animals. Thus organized, the animal is remarkably fitted to his habitation and circumstances.

The flesh of the axolotl is affirmed to be pleasant and wholesome food, resembling that of eels; and it is abundantly eaten by the lower class of people in Mexico. If prejudice could be overcome, it would perhaps be found that all the reptils, without exception, are of the same character, tho they are now beheld with abhorrence.

P. S. Latreille's book on the natural families of animals has come to hand since the preceding paper was written. His divisions correspond very nearly with my own, but he has fallen into the common error of supposing that the axolotl is an immature Salamander.

ART. X.—*Analysis of a specimen of Gold, found to be alloyed with Rhodium.* By Prof. del RIO, of Mexico.*

OF gold of 24 carats, alloyed with at least a third part of rhodium.

In 1810, Mr. Cloud, refiner [now director] of the mint at Philadelphia, discovered that two ingots from Brasil were alloys of gold with palladium: we have here one of gold with rhodium; a discovery hitherto unknown in Europe, like numberless other remarkable things which, under the auspices of liberty, will be brought to light in a country so extensive and highly favoured by nature. In Mr. Cloud's analysis it is observable, that he neither gives the proportional parts, nor even the sp. gr. of the alloy.

I.

Having treated 192.2 grains of an alloy of gold from the smelting house, the sp. gr. of which, according to the Chevalier Mendez, was 15.40, with aqua regia, or hydro-chloronitric acid, a sediment of chloride of silver was formed, which weighed 1.28, equal to 0.97 of silver. From one fourth of the solution the gold was separated by ether, and a galvanic current was observed, which sometimes floated upon the ether, as was natural, and sometimes was found below the aqua regia; which phenomenon certainly deserves a further examination.

Thinking, then, that it was still an alloy, by means of borax a button was obtained, weighing 45.5 grains, which was not ductile, and lost none of its weight by being boiled with nitric acid; and on being fused with an equal quantity of nitre, in a small crucible of platina, much gold adhered to the platina, and the rest appeared like very fine clean salt, with globules of a tin-white color. A lixivium was made with hot water, and decanted; and after washing there remained a ponderous black powder, part of it in the form of very fine short needles; and another less heavy, and of an olive-green color. The filtered lixivium afforded a yellow liquor,

* Translated from the *Sol*, of Dec. 11, 1824, by Dr. WM. SMITH, of the U. S. navy, and read before the New-York Lyceum of Nat. Hist. 8th May, 1826, and ordered to be sent to Prof. SILLIMAN, for publication in the American Journal of Science.

and left the filtre besmeared with black, which, on drying, turned to bright olive-green. The same, saturated with nitric acid, left a sediment of a purplish or cherry red color; and with tincture of galls, one of a dark citron-gray; a proof of its not being *osmium*.

The black powder being separated from the gold by mercury, was dissolved in muriatic acid, and the solution, by boiling, assumed a beautiful orange-red-color. The green could not be reduced by the Chevalier Mendez with the blowpipe, but he observed that some points detonated like nitre, which is a property of rhodium.

This green powder, which I wished to treat separately, being passed with water from a capsule to the matrass, became again black; and on adding it to the red solution, which I had again caused to boil, it appeared gray in the hot water, but resumed its red colour in cold. Into this was put muriate of ammonia, which, by concentrating it, produced an orange-coloured precipitate, which, after decantation and sufficient washing, was dissolved partly in cold water, but mostly in hot, and, by a slow evaporation, yielded an infinite number of orange-coloured crystals. These being reduced per se in the same crucible as before, all the gold appeared with the tin-white rhodium, and in the form of blisters or bubbles.* On twice boiling potash and nitre in the crucible, and casting water into it, the whole of the gold was discovered; and by saturating the lixivium with sulphuric acid, the dark reddish-gray dentoxyd was obtained, which weighed 16 grains, from which 2.14 being subtracted for the oxygen imbibed, 13.86 remain, which is the rhodium; and this being compared with 45.5, shows it to be 30.4 per cent. of alloy.

I cannot omit to mention, that the potash produced minute cavities in the crucible, and that I extracted 130 grains of protoxyd of platina, which were reduced in a clay-crucible, as far as practicable.

Neither the muriatic acid, nor the aqua regia, dissolved all the black powder; the solution of potash dissolved some, and the remainder was treated with fat in a crucible, and many white metallic points were immediately discovered. As they

* I afterwards saw that these bubbles were from the gold, as if it sought to become separated from the platina, and to be united to the rhodium: this always maintained its white colour: would the platina influence it in this respect? I consider it as eminently galvanic.

were not all brilliant, I did not mix it with the former product; but, on reflection, I thought it might be owing to the want of heat, and that I ought to add it, as well as that dissolved by the potash.

II.

From the other three fourths of the solution, the greater part of the acid was distilled, and what remained was saturated with muriate of ammonia without excess. The orange-coloured precipitate lost its redness by time, and changed into an ochre-yellow; for which reason, and because on washing it with hot water, it became greenish, I inferred, that although it detonated like fulminating gold, it was not pure. In fact, having melted 10 grains with borax, after having been infused in oil, a white button* came forth, which was quite rough, and in the interior, where it was observed to be uneven, it had the colour of whitish copper or nickel, leaving a scoria of a leek-green, and cochineal-red colour, and weighing 5.9 grains. The white surface changed after a while, to pinchbeck-gray, and having fused it with nitre, it yielded a globule of pure gold,† which weighed 4.3 grains. Other 10 grains being fused, another button was obtained, which was also without ductility, leaving a scoria of a brighter red, and which weighed 7.1 grains; and being melted in the same way as before, afforded another globule of the same weight as the other, viz. 4.3. Now then, if 100 of ammoniuret yield 43 of gold, 212, which was the weight of the whole, would have given 91.16. Three fourths of the solution would contain 149.40 of the alloy, and abating three fourths of a grain of silver, 148.65; from which the gold being subtracted, there will remain of rhodium 57.49, amounting to 38.6 per cent. of alloy. The sp. gr. of this alloy should be 15.91, but being only 15.40, it follows that there is an augmentation.

The remaining solution was distilled to dryness, and a dark-gray residuum remained, which, treated with muriatic acid, did not exhibit the variations of colour, shown by *iridium;* nor with muriate of ammonia did it yield red crystals,

* The tendency of this metal to appear at the surface of the gold, is very remarkable.

† I attributed the purity of these globules to the circumstance of the bottom and sides of the crucibles having been garnished with borax in excess: the tendency of this to vitrify the rhodium is singular.

but only a double flesh-coloured salt, which could not be crystallized, and which, on drying, resembled pale gray spumous iron. It could not be reduced with the blowpipe by citizen Mendez; and, treated with borax, yielded only a yellowish-green glass.

It is seen then, that neither ether, nor muriate of ammonia, is well adapted to the attainment of a ready and exact separation of the rhodium; I therefore adverted to what Dr. Wollaston says, viz. that it does not amalgamate with mercury.

III.

Accordingly, citizen Mendez submitted to cupellation, an alloy of gold, with rhodium and copper, which was very rough, and weighed 133.7 grains. Two globules were produced, one of 53.87, and the other of 66.13 grains. The first was treated by boiling with mercury and water, and also by trituration in an iron mortar, and a complete amalgamation took place; a bright olive green powder remaining, which, by standing in water, became gradually gray, and turned at length almost greenish black. Was the green a deutoxyde, intermediate between the black and the dark reddish gray? and the greenish black a hydrate? I have a great regard for the opinion of Berzelius, but truth is to be more regarded. Howmuchsoever the amalgam was washed, the regulus of the alloy, after becoming red hot, (rusentado,) exhibited a black spot of rhodium on the bottom, and after fusion with nitre, weighed 49.7; its sp. gr. according to citizen Mendez, was 15, and the weight of the green oxyde, 2.4 grains. I suppose that the sp. gr. was less, on account of its containing three eighths of a grain of silver. The inference is clear, that rhodium amalgamates through the intermedium of gold, although it does not amalgamate *per se*. And I was disappointed in my principal object, which was, to discover if the alloy of silver proceeds from fusion, and not from quicksilver or amalgamation, in order that it might serve as a guide in endeavoring to ascertain whence that and its products derive their origin, which is yet unknown.

IV.

Having seen that neither the protosulphate of iron nor the oxalic acid, precipitated the rhodium, I dissolved in aqua regia, the button of 66.13 grains, whose sp. gr. according to the

Chevalier Mendez, was 15.48, without failing to notice that, on being hammered, it produced spots of a tin-white color on the yellow bottom; a proof of the alloy not being uniform; and it yielded half a grain of muriate of silver, which settled, making three fourths of a grain per cent.; showing the necessity of using sulphuric acid in the extraction and purification of silver at the smelting-house. Proposing to take but half of this solution, for the want of proper tubes I took more, as will be seen by the result, and a precipitate was formed with the protosulphate of iron, and the reduced button weighed 30.7; its sp. gr. being 19.07. I added more of the protosulphate to the solution, and it became like ink; and by refraction in the sun's rays it turned red, with great effervescence and separation of deutoxyd of azote, and when this ceased it became clear. In order to expel the nitric and muriatic acids, I distilled to dryness, and having added water, a great part of the sub-sulphate of iron remained without being dissolved. By adding a little sulphuric acid, and boiling, the whole was dissolved, the liquid assuming a faint carnation colour. Then I put in a small plate of iron, which became copper-red, but by washing in distilled water, the red coating was destroyed, and an indefinable and highly fetid odour was exhaled, which certainly was not that of roses; the same as that emitted by throwing water on that which I fused with potash; so that the Greek name which has been given to it, is not exactly appropriate.* On filtering and washing, a few somewhat flexible pellicles remained, which, when dry, were of a pinchbeck-gray colour, and weighed 10.6. I would willingly omit to mention, that thinking to complete their reduction to the deutoxyde by borax, as I have somewhere read, they came out green glass. Considering them, therefore, as metallic, (and if they were not so, they nearly approached that state,) there results 25.4 per cent. of rhodium, without reckoning what remained in the gold. I recollect that I took the lower half of the solution, which had remained long undisturbed. Would it thus become charged with more gold and less rhodium? I am inclined to this opinion so much the more, as from the fourth part of this solution, precipitated with muriate of ammonia, which should have contained 16.5 of alloy, there could not be obtained more than 9.3 of gold, which give 43 of rhodium in 100 of

* The name appears to have been given by Dr. Wollaston, "from the rose colour of a dilute solution of the salts containing it."—Tr.

alloy. The remainder of the solution took the colour of the protosulphate of iron.

V.

In this state it occurred to the Chevalier Mendez, to add sulphuric acid to the solution in aqua regia, of 10 grains of another alloy, whose sp. gr. was 16.8, and to distil to dryness. When all the muriatic acid had passed over, and the liquor in the retort become very red, he changed the receiver, and a yellow matter passed with the acid, the gold remaining in the retort as if it were massive gold. The yellow matter was partly dissolved in the water, tinging it first yellow and then green, and the remainder formed an ochre-yellow sediment, which would be subtritosulphate of rhodium. On putting water into the retort, the same sediment was formed, which was separated by decantation; and the gold was twice melted with potash and nitre, leaving a scoria, the first time, of a deep pistachio-green colour, and the second of a brighter green; so that it would have been necessary to repeat the process several times, in order to have left the gold perfectly pure: it weighed, in the state in which we leave it, 8.2 grains.

I feel compelled to say, that Dr. Wollaston is in error when he asserts, that the alloys of gold with rhodium are very ductile. The contrary has been observed in the smelting house here for years, and was attributed to the *acridness of the acids*, as if more than one were used, and as if that were not very volatile, and easy of decomposition. We can now conceive, that a rough metal, and in such quantity, must give roughness to the alloys which it forms.

I suppose that men of experience will not now say, that *with the cupel, and two or three acids, any fraud in gold may be discovered;* since, in addition to the examples of platina and palladium, which they before possessed, they now have that of rhodium; and iridium will one day afford also another. In relation to the great waste in the smelting house, I understand that many expedients have been adopted at different times; but these, without experiments, will never discover physical truths; expedients being like the money of the Lacedæmonians, of much bulk, but of little value.

The complete separation of the rhodium, in my opinion, is not to be obtained by softening the gold (as the French express it) with corrosive sublimate; which process, however,

is more chemical than washing the ores of silver, as in Tasco, with zacate? and soap, in order to free them from the black powder, or oxyd of some metal resembling selenium: at least, the Chevalier Mendez and myself met, among these ores, the biseleniuret, of silver in small hexagonal tables, with the salient angles and corners rounded, as if they had been melted; of a leaden-gray colour, and ductile, as may be seen in the *Sol*, *No.* 102, Sept. 24th, 1823. It will be better obtained by treating the alloy with sulphuret of antimony, on account of the greater affinity between the rhodium and the sulphur; a process very successfully employed by a man who the last year purified a quantity for 1800 dollars, making a secret of it, as if this were an age of mysteries, and we were inhabitants of Otaheite.

This analysis is imperfect, in consequence of the unfortunate condition of our laboratory, after having been thirty years in charge of a chemist like Elhuyar, the discoverer of Wolfram and Cerium: it is true, that under the old government he pursued his occupation steadily, through necessity, for he who has once had a taste of the experimental sciences, cannot possibly ever abandon them.

(Signed) ANDRES DEL RIO,
Prof. of Mineralogy in the College of Mines.

Mexico, *Dec.* 9, 1824."

ART. XI.—*Caricography.* By Prof. DEWEY.

(Continued from Vol. XI. p. 167.)

[Communicated to the Lyceum of Nat. Hist. of the Berk. Med. Inst.]

109. C. *sterilis.* Willd.
Muh. Pursh, Eaton, Pers. no. 3.
Ell. no. 1. Schw. and Torrey no. 2.
Schk. tab. Mmm. fig. 146.

Spica composita dioica et androgina; spiculis subquinis sessilibus approximatis, nunc omnino staminiferis suboblongis acutis vel fructiferis ovatis, nunc androgynis superne vel inferne staminiferis ovatis; fructibus distigmaticis ovatis acuminatis vel subrostratis bifidis compresso-triquetris margine scabris, squamam ovatam acutiusculam subæquantibus.

Culm 4—12 inches high, obtusely triquetrous, rather hexangular, striate, growing black below, scabrous above; leaves linear, upper ones long as the culm, shorter below, rough on the edge; staminate spikelets ovate-oblong, rather acute, about five, approximate, sessile, with an ovate scale acute; pistillate spikelets more distinctly ovate, situated like the staminate; androgynous spikelets, like the pistillate, staminate sometimes above and sometimes below; fruit ovate, cordate-ovate (Muh.), acuminated into a short beak, bifid, subcompressed, scabrous on the margin above, reflexed at the apex and diverging, with an ovate scale somewhat acute, white on the margin, and about the length of the fruit.

Flowers in May in the marshes of Penn.—Muh. Common over the country, in wet situations. In the dioecious form, this species is easily distinguished from C. *stellulata* and C. *scirpoides*—but commonly they are probably confounded, as they greatly resemble each other.

110. C. *affinis*. R. Brown.
Schw. and Torrey no. 7.

Spica unica androgyna superne staminifera pauciflora laxa; fructibus tristigmaticis; squamis lanceolatis acutis, infima aristata; foliis planis.

Culm six inches high, triquetrous, subscabrous, leafy towards the base; leaves narrow, linear, flat, shorter than the culm, filiform at the apex; spike single, staminate above, loose-flowered; fruit about five, with a tawny scale; stigmas three. *Mon.*

Found in Arctic America, by Dr. Richardson. See App. Frank. Nar. ed. 2. This plant appears to be exceedingly like C. *polytrichoides*; if the fruit do not differ, it can scarcely be considered more than a variety.

111. C. *attenuata*. R. Brown.
Schw. and Torrey no. 8.

Spica unica androgyna superne staminifera densa; fructibus tristigmaticis paucioribus obternis; squamis omnibus obtusis.

Found in Arctic America, by Dr. Richardson. See App. Frank. Nar. ed. 2.

112. C. *bicolor*. Allion.
Schw. An. Tab. Pers. no. 30. Rees' Cyc. no. 76.
Schw. and Torrey no. 27.
Schk. tab. Aaaa fig. 181.

Spicis androgynis inferne staminiferis ternis ovatis subsessilibus, erectis; fructibus distigmaticis obovatis obtusis subcompressis; squamis ovatis obtusis.

Culm 3—6 inches high—leaves half the length of the culm, linear; fruit elliptic, or obovate obtuse, green, with an ovate scale becoming black; lower spike short-pedunculate and bracteate.

Found in Labrador, by a Moravian missionary, and sent to Mr. Schweinitz—agrees with the European plant. *Mon.*

113. C. *loliacea*. L.
Pers. no. 64. Rees' Cyc. no. 33. Wahl. no. 47.
Schw. and Torrey no. 29.
C. *tenella*, Schk. Car. I. p. 23. tab. Pp. fig. 104.

Spiculis androgynis inferne staminiferis ternis subdistantibus minutis paucifloris sessilibus; fructibus distigmaticis ellipticis vel ovatis obtusis subcompressis divaricatis nervosis ore integris, squama ovata acuta subduplo longioribus.

Culm slender, flexuous; leaves narrow, linear, shorter than the culm, with brownish sheaths towards the base, bract long, setiform, flexuous, under the lowest or two lower spikelets; staminate scale lanceolate; spikelets three or four, small, ovate, sessile, remote, few-flowered, staminate at the base; fruit elliptic, or ovate-obtuse, somewhat compressed, a little diverging, curved, entire at the orifice, with an ovate scale acute, and about half the length of the fruit.

Found in the cedar swamp in New-Durham, N. J.—Dr. Torrey; also in Arctic America—Dr. Richardson.

It is well known that Schk. considered C. *tenella* as the true C. *loliacea*, L.

114. C. *stellulata*. Schreb.
Pers. no. 60. Wahl. no. 46. Rees' Cyc. no. 29.
Schw. and Torrey no. 38.
Schk. tab. C. fig. 14.
C. *echinata*, Retz et al.

Spiculis androgynis inferne staminiferis subquaternis ovatis remotiusculis sessilibus; fructibus distigmaticis ovatis acu-

minatis compressis subbifidis margine scabris divergentibus et reflexis, squama ovata obtusiuscula paulo longioribus.

Culm 4—14 inches high, triquetrous, rather slender, leafy towards the base; leaves linear, shorter or even longer than the culm, rough on the edge; spikelets three to five, ovate except the highest, which is elongated by the staminate flowers decurrent at the base, somewhat approximate, lower often more remote and supported by a long linear bract scabrous; stigmas two; fruit ovate, somewhat cordate at the base, short-acuminate, scabrous on the margin, plano-convex, nearly entire or slightly bifid, spreading, reflexed in maturity; pistillate scale ovate, tawny, whitish on the margin, a little shorter than the fruit. Colour of the plant yellowish green.

Flowers in May—grows in marshy situations in meadows and pastures and along woods—common in our country, as well as in Europe.

This species was considered by the English botanists as the C. *muricata*, L., until the acquisition of the Herbarium of Linnæus showed their mistake. Under this name it was described by many. Indeed, Wahl. considers this plant to be C. *muricata*, L. in Flor. Suec. though it is not the plant described afterwards by Linnæus under this name, which has the staminate flowers above the pistillate. The resemblance of C. *scirpoides* to C. *stellulata* led Muh. to ask whether it *is sufficiently distinct* from it. In C. *stellulata* all the spikelets are androgynous; in C. *scirpoides*, the upper spikelet is androgynous, while the others are entirely pistillate, or have few staminate florets,—the pistillate scale too is more lanceolate, and more obtuse in proportion. Still it is certain that the varieties of C. *stellulata*, C. *sterilis*, and C. *scirpoidea*, are extremely near each other.

115. C. *muricata*. L.
Pursh, Eaton, Pers. no. 57. Wahl. no. 28.
Rees' Cyc. no. 28.
Schk. tab. E. and Dd fig. 22.

Spica composita androgyna; spiculis subsenis superne staminiferis ovatis sessilibus approximatis, sæpe inferioribus subremotis; fructibus distigmaticis ovatis vel ovato-oblongis acuminatis convexo-planis divergentibus bifidis margine scabris, squama ovatâ duplo longioribus vel ovato-lanceolatæ æqualibus.

Culm a foot or more in height, triquetrous, scabrous above, leafy towards the base; leaves linear-lanceolate, flat, scabrous on the edge, rather smooth and soft, often surpassing the culm, striate with striate sheaths; bract sometimes long and leafy under the lowest spikelet, sometimes none or small; spikelets three to seven, ovate, sessile, sometimes aggregated, sometimes rather remote below, staminate at the summit and few-flowered; stigmas two; fruit ovate, acuminate, plano-convex, diverging or horizontal, scabrous on the margin, bifid, pistillate scale ovate and about half the length of the fruit, or ovate-lanceolate equalling the fruit, tawny or green, with a whitish edge. Color of the plant varying from a bright to a yellowish green.

Flowers in May—grows about woods and hedges—common.

On the specimens of C. *muricata* from England and Germany, the scale of the fruit is of unequal lengths, sometimes scarcely exceeding half the length of the fruit. In this particular, our plant is like the European. The form of the plant, on tab. E. fig. 22, is not very common.

The following variety is much more frequent.

β. *cephaloidea*, (Mihi.)

C. *loliacea*, Schk. Car. I. p. 22. tab. Ee fig. 91.

C. *muricata* Wahl.

Spiculis aggregatis subquinis arcte sessilibus; fructibus ovatis, squama duplo longioribus.

The plant called C. *loliacea*, by Schk. Car. I. p. 22, he afterwards considered a variety of C. *muricata*. The scale is shorter on our plant than is shown on his figure. Culm a foot or more high, and in rich shaded hedges often four feet, and decumbent from its weight, acutely triquetrous; spikelets commonly aggregated, yellowish; fruit horizontal; pistillate scale ovate, small, rarely exceeding half the length of the fruit; common. The spikelets are exceedingly like those on tab. Ee fig. 91, and the plant belongs to no other species described, and is described by no botanist of our country unless under the name of C. *muricata*.

C. *divulsa*, Gooden. is credited to our country by Pursh, and is considered by Wahl. as only a variety of C. *muricata*, —it is, at least, very near it. I have never found a variety, however, which was like the specimens of C. *divulsa* received from Europe. One form of C. *sparganioides* exactly resembles the figure of C. *divulsa*, Schk. tab. Dd. fig. 89, and is

probably the plant intended by Pursh. Had I not found it growing upon the same root with the common C. *sparganioides*, I should have referred it to the same figure in Schk. It is probably a form of this variety, which is called C. Nuttallii, Schw. An. tab.

116. C. *remota*. L.
Pursh, Wahl. no. 51. Rees' Cyc. no. 40.
Pers. no. 68. Schw. and Torrey no. 42.
Schk. tab. E. fig. 23.

Spiculis androgynis inferne staminiferis numerosis ovato-oblongis subsessilibus, inferioribus distantibus, bractea longissima foliacea suffultis; fructibus distigmaticis ovatis acuminatis bifidis convexo-planiusculis subbifidis, squama ovato-lanceolata paulo longioribus.

Culm 12—20 inches high, leafy, slender, flexuous; leaves linear, rather narrow, often surpassing the culm; bracts very long, linear, leafy, under the lower spikelets; stigmas two; spikelets ovate-oblong, numerous, nearly sessile, staminate below, approximate towards the summit, lower ones quite remote; fruit ovate, acuminate, or oblong-ovate, bifid, somewhat compressed, a little longer than the ovate scale.

Flowers in May—found in woods on the mountains of Penn.—Pursh; in Arctic America—Dr. Richardson.

The fig. in Schk. is very fine—on my European specimens the spikelets vary from five to twelve.

117. C. *media*. R. Brown.
Schw. and Torrey no. 44.

Spicis androgynis inferne staminiferis tristigmaticis ternis subsessilibus approximatis; fructibus ovatis rostratis glaberrimis, squama ovata obtusiuscula longioribus.

Found in Arctic America, by Dr. Richardson. Mon. See App. Frank. Nar. ed. 2. Though nearly allied to C. *bicolor*, it appears to be a distinct species.

118. C. *concolor*. R. Brown.
Schw. and Torrey no. 55.

Spica staminifera solitaria; spicis fructiferis distigmaticis binis vel ternis erectis subsessilibus; fructibus ovalibus mucronatis integerrimis laevibus; squamis omnibus subconcoloribus obtusis; culmis laevibus; bracteis auriculatis.

Found on Melville Island—said to resemble C. *caespitosa*, *Mon.*

119. C. *mutica.* R. Brown.
Schw. and Torrey no. 56.

Spica staminifera solitaria, squamis obtusis; spicis fructiferis tristigmaticis ternis distantibus erectis subexserte pedunculatis, fructibus ovalibus muticis laevibus, squama ovata mucronata longioribus; foliis bracteisque planis.

Found in Arctic America, by Dr. Richardson. *Mon.* See App. Frank. Nar. ed. 2.

120. C. *saxatilis.* L.
Pursh, Eaton, Pers. no. 114. Wahl. no. 140.
Schw. An. Tab. Rees' Cyc. no. 90.
Schk. tab. T and Tt fig. 40.
C. *Bigelowii,* Torrey in Schw. An. Tab.
— *compacta,* R. Brown? Schw. and Tor. no. 54.

Spica staminifera solitaria oblonga erecta, squamis obtusis; spicis fructiferis *distigmaticis* subternis alternis, superioribus ovatis sessilibus, inferioribus suboblongis brevi-pedunculatis bracteatis; fructibus ovatis obtusis vel oblongo-ovalibus subcompressis ore integris subpubescentibus, squamam ovatam obtusam subæquantibus.

This species is given on the authority of Pursh, who found it in the hemlock woods of Vermont and New-Hampshire. It has been considered doubtful whether the plant inhabits our country, and Pursh has been thought to have mistaken the C. *Washingtoniana,* Vol. X. p. 272 of this Journal, the C. *nigra,* no. 69 of the *Mon.* for the above species. The difference between C. *saxatilis,* and C. *Washingtoniana,* in the number of stigmas and the form of the spikes, is too great to render the supposition probable. The same is true also in relation to these two species and the C. *nigra,* as shown by Schk tab. Aaa fig. 115, and as described by European authors. The three are very different in various respects. It seems the more probable that Pursh was not mistaken, as the C. *compacta,* R. Brown, found in Arctic America, is stated to resemble C. *saxatilis,* and is perhaps a variety of it. This species is found in Alpine districts of the north of Europe. Culm triquetrous, glabrous, leafy towards the base; leaves linear-lanceolate, shorter than the culm; bract leafy, auriculate, under one or more of the lower spikes and longer, with short sheaths; staminate spike single, erect, oblong, with nearly linear and often very obtuse scales; pistillate spikes two to five, upper ones ovate and sessile, lower ones rather

oblong, exsertly and short-pedunculate, nearly black, rather densely flowered; stigmas two; fruit ovate, or oblong-oval, obtuse, rather compressed, entire at the orifice, slightly pubescent; pistillate scale ovate, obtuse, black, and about the length of the fruit.

Note. A description of C. *Willdenowii*, vol. IX. p. 258, from perfect specimens, here follows,

C. *Willdenowii.* Schk.
Muh., Pursh, Eaton, Pers. no. 5.
Ell. no. 4. Schw. and Torrey no. 5.
Schk. tab. Mmm, fig. 145.
C. *Jamesii*, Schw. An. Tab.

Culmis vel pedunculis 1—3 ex radice eadem; spica unica superne staminifera basi ovata; fructibus 3—6, tristigmaticis ovato-globosis rostratis subinflatis subtriquetris; squamis ovatis acutis inferioribus foliiformibus longissimis spica permulto longioribus.

Obs. Variat interdum cum spica staminifera distincta.

Culm 3—12 inches high, one to three from the same sheaths, acutely triquetrous, scabrous above, lax, the two lowest like common peduncles and shorter; leaves subradical, linear, rough on the edge, flat, striate, often much longer than the culm, with brownish sheaths; spike single, staminate above, ovate at the base, in maturity; staminate flowers about six, sometimes on a separate spike, with short and obtuse scales, whitish on the edges; stigmas three; fruit three to six, ovate-globose, glabrous, slightly triquetrous, some inflated, rostrate, nearly entire at the orifice, before maturity lanceolate, or ovate-lanceolate, the beak scabrous under a lens; pistillate scale very various, the upper ovate and acute, and about the length of the fruit; the lower leaf-like, broad, linear-lanceolate, many times longer than the spike. Colour of the plant light green.

Flowers in June—grows in dry woods in Penn.—Muh.; also in Ohio.—Dr. E. James.

The figure of Schk. was drawn from a specimen, upon which the fruit was not mature, and the fruit is not represented sufficiently *globose* at the base, but as too nearly lanceolate. The *leaf-like* scales of the lower fruit are not drawn of near the length which they often have.

121. C. *tetanica*. Schk.
Schk. Car. II. p. 68. tab. Oooo fig. 207.
Schk. tab. Ggg fig. 100?

Spica staminifera solitaria pedunculata; spicis fructiferis tristigmaticis binis vel ternis remotis, infima longo-pedunculata; fructibus obovatis apice recurvis ore integris, squama ovata obtusa longioribus.

There is much obscurity resting upon this species, and some mistake must have been made. Schk. referred two figures to the same species, and yet there can scarcely be a doubt that tab. Ggg fig. 100, was drawn from a variety of C. *pyriformis*, Schw., the C. *aurea*, Nutt., as the fruit and upper pistillate scales often agree exactly with this figure, and the opened fruit shows the same dark, compressed, and obovate seed, drawn on the fig. of Schk.: and Muhlenberg *doubted whether both or even either of the figures of Schk.* answered to the plant which he described under the same name. And certainly the characters of the fruit, given by Muh., viz. *ovate, acute at both ends, and nerved,* are entirely at variance with those given above from the description of Schk. We learn too from the *Mon.* that the C. *tetanica* in the Herbarium of Muh. is clearly the C. *granularioides*, Schw., which is the true C. *conoidea* of Schk., as remarked Vol. X. p. 47. The C. *tetanica* of Muh. Herb. and of the *Mon.* is obviously a very distinct plant from the C. *tetanica*, Schk. described above. A new name has already been given to it by Dr. Schw., and it is also C. *conoidea* Schk. The C. *tetanica*, Schk. must retain the name given by that botanist. Until the specimens shall have been actually compared with those from which Schk. drew his figures, this is the only safe course. I have a species of Carex which agrees very nearly with the description and figure of Schk., and must at least be a variety of the real C. *tetanica*. I had a full opportunity of examining it in its fresh state. It has the following characters, and corresponds very nearly with tab. Oooo fig. 207.

Culm 6—10 inches high, triquetrous, scabrous above; leaves flat, linear-lanceolate, shorter than the culm; bracts linear, long, surpassing the culm, with short sheaths; staminate spike single, erect, long-pedunculate, with oblong and obtuse scales, tawny, green on the keel; stigmas three; pistillate spikes two, sometimes three, oblong, loose-flowered, remote,—upper sub-sessile, the lower exsertly pedunculate; fruit ovate and acute at both ends in its young state, and recurved at

the apex,—when mature, obovate, sometimes recurved, glabrous; pistillate scale ovate, distinctly mucronate below, less in the middle of the spike, and often only acutish at the summit, green on the keel, shorter than the fruit. Colour light green.

Flowers in May—moist meadows, in Stockbridge, Mass.

122. C. *Halseyana.* Dewey.
Vol. XI. tab. N. fig. 43.

Spicis staminiferis subbinis oblongis erectis sessilibus approximatis a fructifera remotis, suprema longiore; spica fructifera tristigmatica solitaria oblonga cylindracea exserte pedunculata erecta sublaxiflora, raro binis distantibus et suprema superne staminifera; fructibus ovali-ovatis brevi-rostratis subtriquetris inflatis nervosis glabris ore obliquis, squama ovata acutiuscula paulo longioribus.

Culm 1—2 feet high, erect, acutely triquetrous, minutely scabrous, purplish towards the base; leaves linear-lanceolate, about half as long as the culm, shorter below, rough on the edge, sheathing towards the base; bracts linear-lanceolate, leafy, shorter than the culm, with sheaths white opposite to the leaf; staminate spikes one to four, generally two, approximate, sessile, lower ones short, upper one about an inch long, densely imbricate, remote from the pistillate spike,—with an oblong and obtuse scale, tawny, white on the edge, green on the keel, and the lower one sometimes with a few fruit; stigmas three; pistillate spike single, sometimes two, erect, oblong-cylindric, exsertly pedunculate, somewhat loose-flowered,—when two, the lower remote, and the upper sometimes staminate at the apex; fruit ovate, or oval-ovate, slightly inflated, glabrous, nerved, sub-triquetrous,—with a short beak, reddish brown, and its orifice white and oblique; pistillate scale ovate, somewhat acute, sometimes rather obtuse, reddish-brown, white on the edge, green on the keel, varying from more than half to nearly the length of the fruit. Color of the plant dark green.

Flowers in May—grows in upland meadows, Westfield, Mass.—found by Mr. E. Davis, principal of the academy, an accurate and indefatigable botanist.

This beautiful species bears some resemblance to C. *vestita,* which has sometimes two staminate spikes; but the spikes of this plant are longer and not sessile, and in most of its characters it differs from any American species hitherto described.

123. C. *collecta.* Dewey.
Tab. N. fig. 44.

Spica staminifera solitaria erecta laxe imbricatis gracili sub-pedunculata; spicis fructiferis tristigmaticis subternis ovatis paucifloris bracteatis, inferiore brevi-pedunculata; fructibus ovatis rostratis sub-bidentatis sub-pubescentibus, squama ovata acuta paulo longioribus.

Culm 6—16 inches high, triquetrous, scabrous above, procumbent in maturity, very slender, leaves linear, subradical, shorter below, upper also shorter than the culm, narrow, minutely scabrous on the edge, soft, bracts linear, lower one about equalling the culm, staminate spike single, erect, slender, nearly half an inch long, scales oblong, long-acute, whitish-yellow, white on the edge, green on the keel and scabrous, loosely imbricate; stigmas three; pistillate spikes two to four, ovate, small, sessile, few-flowered, bracteate, lower one pedunculate; fruit ovate, rostrate, slightly bidentate, subpubescent, and ciliate serrate on the beak; pistillate scale ovate, acute, large, light yellow, white on the edge, green and scabrous on the keel, shorter than the fruit. Color of the plant light green. Seed ovate, triquetrous.

Flowers in May—grows in small bogs on the border of a high sphagnous marsh, Worthington, Mass. with C. *curta.*

Related to C. *novæ-angliæ*—but differs in the number of stigmas, and in other characters. From C. *varia* it differs in its manner of growth, as well as in its staminate spike, scale, and in its fruit being more ovate, less globose, slightly pubescent, and scabrous or ciliate-serrate along the beak.

124. C. *verna.* Vill. Pers. no. 103.
— *præcox.* Jacq. Wahl. no. 98. Pers. no. 91.
Schk. tab. fig. 27.

Spica staminifera solitaria erecta; spicis fructiferis tristigmaticis binis ovato-oblongis approximatis sub-pedunculatis; fructibus ovalibus subtriquetris acutis pubescentibus, squama ovato-oblonga sub-mucronata paulo brevioribus.

Culm 2—6 inches high, triquetrous, smooth; leaves subradical, linear, scabrous on the edge, rigid, spreading, longer than the culm; sheaths short, terminated by a short, lanceolate, acute bract; staminate spike single, erect, oblong, pedunculate, sometimes with a few pistillate florets at the base; staminate scale oval, rather long, obtuse, tawny; stigmas three; pistillate spikes two, approximate, ovate-oblong, sub-

sessile, lowest short-pedunculate, fruit oval, subtriquetrous, acute, pubescent; pistillate scale ovate, rather broad, somewhat acute or sub-mucronate, dark-colored, and a little longer than the fruit. Color pale or yellowish-green.

Flowers in May—grows on "rocky hills in the north part of Salem, Mass."—found by Dr. C. Pickering this season, for the first time in our country. It is a common European species. On the specimens of this species received from Germany, the pistillate scale is sometimes only acute, on others it is short-mucronate. On the plant sent me by Dr. Pickering, it has commonly the latter form. The whole plant very closely resembles the European, except that the scales are rather lighter colored. It should be remarked that this plant *is not* the C. *præcox*, Schreb., the C. *Schreberi*, Schk. tab. B. fig. 9.

Remark. Additions and Corrections.

To C. *bullata*, Vol. IX. p. 71, should have been added the following variety.

C. *bullata*. Schk.

β. *cylindracea*, Mihi. C. *cylindrica*, Schw. An. Tab.

Spicis staminiferis longo-pedunculatis; spicis fructiferis longo-cylindraceis subdensifloris; fructibus longo rostratis.

In this variety, the fruit is much more close than in the common form, less inflated, and with a beak longer in proportion and very slightly scabrous.

Found in S. Carolina—Schw.; also, with the common variety in New-England.

Also, to C. *hirsuta*, Vol. IX. p. 60, the following variety.

C. *hirsuta*. Willd.

Schw. and Torrey no. 47.

β. *pedunculata*, Torrey.

Spicis oblongo-cylindraceis pedunculatis; foliis leviter pubescentibus.

The lower spikes of this variety are longer and distinctly pedunculate, although the peduncles are short; the leaves are slightly and sometimes scarcely pubescent.

Grows in Phillipstown, Highlands, N. Y.—Dr. Barratt; also in the meadows S. of Newburgh, N. Y. with C. squarrosa, C. gracillima, and the common variety; found also in this town.

Also—the C. *alba* of our country, Vol. VII. p. 266, must be considered a variety of the European species, on account of the difference in the leaves.

C. *alba*. Haenke.
Schw. and Torrey no. 75.
β. *setifolia*, Dewey, Vol. XI. tab. H. fig. 28.

The leaves are *bristle-form*, slender, rather stiff, and erect till near maturity. It is rather smaller than the specimens from Europe. In other respects it does not differ. In the form and colour of the fruit and scale, and in the hyaline, obtuse, leafless sheaths, the resemblance is complete.

Grows on light rocky soil, Pownal, Vt. and Goat Island, N. Y.—abundant at the latter place. Also, at Watertown, N. Y.—Dr. Crawe; *Mon*.

Also—to C. *squarrosa*, Vol. VII. p. 270, the following variety.

C. *squarrosa*, L. Vol. XI. tab. I. fig. 29.
Schw. and Torrey no. 11.
β. *typhinoides*, Dewey. C. *typhinoides*, Schw. An. Tab.

Spicis longo-cylindraceis superne attenuatis subbinis sæpe approximatis.

Spikes long-cylindric, attenuated above, one to three, more or less pedunculate, often approximate; large and leafy bract under the lower spike; leaves appear to be less rigid.

Found in N. Carolina—Schw. This appears to be only a variety of C. *squarrosa*—the fruit has three stigmas, though it is referred in the An. Tab. to those which have only two, and the scales do not differ. As all the descriptions of C. *squarrosa* implied there was *only one spike*, this was naturally considered distinct. But the common variety is found to have from one to three spikes, similarly situated to these, as shown in the *Monograph*, Pl. 27, fig. 2. The specimens I received from Dr. Barratt, collected in the Highlands of N. Y. have one, two, and three spikes. It becomes necessary to amend the description of C. *squarrosa*, L. by this difference in the number of spikes. The lower ones too appear to have much fewer staminate florets than the highest, or to be destitute of them. The figure of C. squarrosa, Vol. XI. tab. I. fig. 29, shows the common variety before the fruit is matured.

Also—to C. *umbellata*, Vol. X. p. 31, the following variety.

C. *umbellata.* Schk.
Schw. and Torrey no. 89.
β. *vicina*, Dewey. Vol. X. tab. D. fig. 13.

Spica fructifera unica staminiferæ approximata sessili; ceteris fructiferis, cum pedunculis radicalibus.

One sessile pistillate spike ovate and at the base of the staminate, with two or three radical peduncles bearing each a pistillate spike, as in the common variety.

As this variety is found growing on the same root with the other, there can be no doubt about it, although the fig. in Schk. and all the descriptions given before that in this Journal, Vol. X. imply that all the pistillate spikes are on radical peduncles. This variety too is very common.

Also—C. *multiflora.* Muh.
Schw. and Torrey no. 21.
β. *microsperma*, Dewey, Vol. X. tab. F. fig. 19.
C. *microsperma*, Wahl.

The characters are given from Wahl. in Vol. IX. p. 61. The spike as a whole less compact than in the common variety—but the spikelets close aggregated; the fruit less compressed, shorter, with a shorter and less acuminate beak. Grows in the same situations as the common, and the spikes are often large.

The C. *bracteosa*, and C. *polymorpha*, Schw. An. Tab. are said in the *Mon.* to be only varieties of C. *multiflora*.

C. *Collinsii.* Nutt.
Nutt. Genera, Vol. II. p. 205.
C. *Michauxii*, Dewey, Vol. X. p. 273, tab. G. fig. 21.
— *subulata*, Mx. and *Mon.* no. 73.

As Wahl. had established a species under the name of C. *subulata*, it became necessary to change the name given by Mx. to this species. But as Mr. Nuttall had given the plant another name previously, justice requires that this species should be called C. *Collinsii.* Though I have never seen the termination of the fruit so much *recurved*, there can be no doubt that Mr. Nuttall respected the plant which I called C. *Michauxii.* I adopt his name for this species.

C. *affinis.* R. Br. Vol. XI. p.
C. *rupestris*, All. ? Schk. tab. Nnnn. fig. 200.

The description of C. *affinis* shows it to be very near, if not identical with C. *rupestris*, Allion.

C. *cespitosa*, Vol. X. p. 266.

Lower pistillate spike often with one to three branches at its base.

C. *pseudo-cyperus*, Vol. IX. p. 71.

The staminate spike is sometimes androgynous, having a cluster of pistillate flowers at the summit.

C. *straminea*, Vol. XI. p. 157.

γ. *minor*, Dewey, Vol. XI. tab. N. fig. 45.

Spiculis parvis subsenis obovatis; fructibus ovatis acuminatis compressis alatis serrulatis, squamam ovatam acutam subæquantibus.

In this variety, found in cultivated fields, the spikelets are much smaller than in the common one, less globose, nearly obovate, more remote in proportion to their size; the fruit is smaller, less round, less broadly winged, and about equal in length to the ovate and acute scale. Although this variety appears pretty remote from the common form, there is full reason to consider it only as a variety.

Figures of the following species accompany this paper.

Tab. M. fig. 38.	C. dasycarpa	Vol. XI. p. 148
	39—glaucescens	XI. p. 150
	40—Elliottii	XI. p 151
	41—verrucosa	XI. p. 159
	42—trichocarpa	
	β. turbinata	XI. p. 159
Tab. N. fig.	43—Halseyana	XI. p. 313
	44—collecta	XI. p. 314
	45—straminea γ minor	XI. p. 318
	46—plantaginea	XI. p. 155.
	47—anceps	X. p. 36.
	a. Broad radical leaf.	
	b. Narrow and long hyemal leaf.	
	48—lupulina	
	β. polystachia	XI. p. 166
	49—tetanica	XI p. 312

Note. This Caricography contains descriptions of *one hundred and twenty-eight* species of Carex found in North-America. It embraces all the fifty-nine species described by Muhlenberg, except his C. *polymorpha*, which is probably a variety of C. *Buxbaumii*. In the Flora of Pursh, sixty-four species of Carex are described. Of these, C. *arenaria*, C. *divulsa*, C. *leporina*, C. *ovalis*, and C. *distans*, have not

been found by later botanists, even in the very localities mentioned by that author. These several species, common in Europe, are generally supposed not to inhabit our country. The other species in Pursh's Flora have been introduced into this Caricography. Of the numerous species in the An. Tab. of Dr. Schweinitz, most have been introduced into this work, as species or varieties well ascertained. Future examinations may detect some mistakes, or discover other species, which may be the subject of another paper. Figures of forty-nine species and varieties have been given in this work, embracing all the new to which the writer had access. By some, there will be thought to be a too great increase of species. The present hostility to the introduction of new species is favourable to the cause of natural science. In his *Discourse before the New-York Alpha of the* Φ. B. K. *Society*, His Excellency DeWitt Clinton expressed the general opinion of scientific men upon this subject. Still it is evident, that this principle may, like every other, be carried to an unreasonable extreme, and one which shall be equally injurious to science. The natural history of any genus *cannot be perfect*, until all the really distinct species are recognized and described as such. And though "every minute difference, every trifling variation" is not to constitute a new species, the language or practice even of Linnæus will not authorize the rejection of important and constant differences. Upon them he founded all the species he described. Upon the same, every observer is authorised to proceed, until the science is perfected. There can be little doubt that future observers will add many species to those already described.

Systematic Arrangement and Index of the North American Species of Carex.

I. Stigmas two.

A. *Spike single. Diœcious.*

* Those species marked with an asterisk are common to Europe and this country.

B. *Spikes several. Diœcious and androgynous, with stamens and pistils variously situated.*

3.	—— sterilis, Willd.	Vol. XI. p. 304
4.	—— bromoides, Schk.	VIII. p. 264

C. *Spikes several. Androgynous.*

1. *Stamens at the summit of the spikelets.*

5.	—— cephalophora, Willd.	VII. p. 269 & X. p. 268
6.	—— rosea, Schk.	X. p. 276
	—— β. *radiata*, Dewey,	X. p. 276 & XI. tab. H. fig. 24
7.	—— retroflexa, Muh.	VII. p. 271 & X. p. 277
8.	—— Muhlenbergii, Schk.	VIII. p. 265
9.	—— stipata, Muh.	VII. p. 271 & X. p. 277
	—— *vulpinoidea*, Mx.	
10.	—— multiflora, Muh.	IX. p. 60
	β. microsperma, Dewey,	XI. p. 317 & X. tab. F. fig. 19
11.	—— sparganioides, Muh.	VIII. p. 265
12.	—— disperma, Dewey,	VIII. p. 266 & IX. tab. A. fig. 3
13.	—— setacea, Dewey,	IX. p. 61, tab. B. fig. 5
14.	—— paniculata,* L. & Muh.	X. p. 275
	—— *decomposita*, Muh.	
15.	—— teretiuscula,* Gooden.	VII. p. 265
16.	—— muricata,* L.	XI. p. 307
	β. cephaloidea, Dewey,	XI. p. 308

2. *Stamens at the base of the spikelets.*

17.	—— bicolor,* Allion.	XI. p. 306
18.	—— loliacea,* L.	XI. p. 306
19.	—— Deweyana, Schw.	IX. p. 62, tab. C. fig. 11
20.	—— trisperma, Dewey,	IX. p. 63, tab. C. fig. 12
21.	—— scoparia, Schk.	VIII. p. 94
	—— *leporina*, Mx.	
22.	—— lagopodioides, Schk.	VIII. p. 95
	—— *tribuloides*, Wahl.	
	—— *Richardi*, Mx.	
23.	—— straminea, Willd.	VII. p. 276 & XI. p. 157
	β. brevior, Dewey,	XI. p. 158
	— *straminea*, Wahl.	
	γ. minor, Dewey,	XI. p. 318 tab. N. fig. 45
24.	—— fœna, Muh.	X. p. 284
25.	—— cristata, Schw.	X. p. 44 & XI. tab. K. fig. 31
26.	—— Muskingumensis, Schw.	X. p. 281 & XI. tab. L. fig. 35
	—— *arida*, Schw. and Torrey.	
27.	—— stellulata,* Schreb.	XI. p. 306
	—— *echinata*, Retz et al.	
28.	—— scirpoides, Schk.	VIII. p. 96
	—— *triceps*, Mx.	

29. ——	curta,* Gooden.	VIII. p. 93
——	*canescens*, L. et al.	
30. ——	festucacea, Schk.	VIII. p. 96
31. ——	remota,* L.	XI. p. 309
32. ——	tenera, Dewey,	VIII. p. 97 & IX. tab. C fig. 9

3. *Stamens at the apex of the highest and lowest spikelets,—the middle spikelets entirely staminate.*

33. ——	siccata, Dewey,	X. p. 278. tab. F fig. 18

D. *Stamens and stigmas on separate spikes.*

1. *Staminate spike single.*

34. ——	novæ angliæ, Schw.	IX. p. 64. tab. B fig. 7
35. ——	floridana, Schw.	X. p. 45, tab. G 22 & 23
36. ——	aurea, Nuttall,	X. p. 48
	pyriformis, Schw.	IX. p. 69 & XI. tab. I fig. 30
37. ——	concolor, R. Brown,	XI. p. 309
38. ——	mutica, R. Br.	XI. p. 310
39. ——	saxatilis,* L.	XI. p. 310
	β. *compacta*, R. Br. ?	XI. p. 310

2. *Staminate spikes two or more.*

40. ——	acuta,* L.	X. p. 265
	β. erecta, Dewey,	X. p. 265
	γ. sparsiflora, Dewey,	X. p. 265
41. ——	cespitosa,* L.	X. p. 266
42. ——	aquatilis,* Wahl.	X. p. 267
43. ——	stricta,* Gooden.	X. p. 269
44. ——	crinita,* Lam.	X. p. 270
——	*leonura*, Wahl.	
	β. paleacea, Ph.	X. p. 270
	γ. gynandra, Dewey,	X. p. 270

II. Stigmas three.

E. *Spikes androgynous.*

a. *Stamens at the summit.*

1. *Spike single.*

45. ——	polytrichoides, Muh.	IX. p. 258
——	*microstachia*, Mx.	
——	*leptalea*, Wahl.	
46. ——	leucoglochin,* Ehrh.	X. p. 42
——	*pauciflora*, Lightf. & al.	
47. ——	affinis, R. Br.	XI. p. 305
——	*rupestris*, Allion.	XI. p. 317

48. —— attenuata, R. Br. XI. p. 305
49. —— filifolia, Nutt. XI. p. 150
50. —— Fraseri, Sims. XI. p. 155
—— *lagopus*, Muh.

2. Spikes several.

51. —— ovata, Rudge X. p. 44

3. One, sometimes more, radical peduncles, with single spikes.

52. —— Wildenowii, Schk. IX. p. 258 & XI. p. 311
—— *Jamesii* Schw.

4. Several radical peduncles, with single spikes.

53. —— pedunculata, Muh. IX. p. 259

b. *Stamens at the base of the spikes.*

1. Spike one, sometimes more.

54. —— squarrosa, L. VII. p. 270 & XI. tab. I fig. 29
—— *typhina*, Mx.
β. typhinoides, Dewey, XI. p. 316

2. Spikes several.

55. —— atrata,* L. X. p. 271
56. —— media, R. Br. XI. p. 309

F. *Terminal spike androgynous, pistillate at the summit; the others wholly pistillate.*

57. —— virescens, Muh. IX. p. 259
β. costata, Dewey
58. —— hirsuta, Willd. IX. p. 260
β. pedunculata, Torrey XI. p. 315
59. —— Buxbaumii,* Wahl. X. p. 39
—— *polygama*, Schk.
60. —— viridula, Mx. XI. p. 153
—— *triceps*, Elliott.
61. —— formosa, Dewey, VIII. p. 98 & IX. tab. B fig. 6
62. —— gracillima, Schw. VIII. p. 98 & XI. tab. I fig. 28
—— *digitalis*, Schw. and Torrey.
63. —— misandra, R. Br. XI. p. 153
64. —— Torreyana, Dewey, X. p. 47
—— *aristata*, Dewey, VII. p. 277 & IX. tab. A fig. 1
—— *Davisii*, Torrey.
65. —— fuliginosa,* Schk. XI. p. 152

G. *Staminate* spike single.

1. *Pistillate spikes sessile or with inclosed peduncles.*

66. ——	pubescens, Muh.	IX. p. 73
67. ——	vestita, Willd.	IX. p. 261
68. ——	varia, Muh.	XI. p. 162
	β. pedicellata, Dewey	XI. p. 162
69. ——	marginata, Muh.	XI. p. 163
——	*pennsylvanica*, Lam.	
70. ——	dasycarpa, Muh.	XI. p. 148. tab. M fig. 38
71. ——	Richardsonii, R. Br.	XI. p. 152
72. ——	concinna, R. Br.	XI. p. 152
73. ——	flava,* L.	IX. p. 65
74. ——	Oederi,* Ehrh.	X. p. 38
——	*irregularis*, Schw.	
75. ——	tentaculata, Muh.	X. p. 34
——	*rostrata*, Mx.	
76. ——	Collinsii, Nutt.	XI. p. 317
——	*Michauxii*, Dewey,	X. p. 27. tab. G fig. 21
——	*subulata*, Mx. and *Mon.*	
77. ——	folliculata, L.	X. p. 32
——	*intumescens*, Rudge.	
78. ——	xanthophysa, Wahl.	VII. p. 274 and X. tab. D fig. 15
79. ——	lupulina, Muh.	XI. p. 165. tab. L fig. 37
——	*lurida*, Wahl.	
	β. polystachia, Torrey	XI. p. 166. tab. N fig. 4
80. ——	Davisii, Dewey,	X. p. 279 and XI. tab. H fig. 25
——	*alpestris*, Allion. & Mon.	
81. ——	nigro-marginata, Schw.	X. p. 282 & XI. tab. H. fig. 27
82. ——	collecta, Dewey,	XI. p. 314 tab. N. fig. 44

2. *Pistillate spikes exsertly pedunculate.*

83. ——	plantaginea, Lam.	VII. p. 272. & XI. p. 155 tab. N fig. 46
	latifolia, Wahl.	
84. ——	anceps, Schk.	X. p. 36. & XI. tab. N fig. 47
——	*plantaginea*, Muh.	
——	*heterosperma*, Wahl.	
——	*striatula*, Mx.	
85. ——	alba, Haenke,*	VII. p. 266
	β. setifolia, Dewey,	XI. p. 316. tab. H fig. 26.
86. ——	oligocarpa, Schk.	X. p. 280
	β. *Van Vleckii*, Dewey,	X. p. 281. tab. F fig. 20
87. ——	conoidea, Schk.	X. p. 47
——	*granularioides*, Schw.	IX. p. 262. tab. A fig. 4
——	*tetanica*, Muh. and *Mon.*	
88. ——	granularis, Muh.	VII. p. 272. & XI. p. 156

89.	—— scabrata, Schw.	IX. p. 66. & XI. tab. K fig. 32
90.	—— blanda, Dewey,	X. p. 45. & XI. tab. K fig. 33
	—— *conoidea*, Muh. and *Mon.*	
91.	—— laxiflora, Lam.	X. p. 31
	—— *grisea*, Wahl.	
	—— *paupercula*, Mx.	
92.	—— ustulata,* Wahl.	XI. p. 149
93.	—— capillaris,* L.	XI. p. 149
94.	—— podocarpa, R. Br.	XI. p. 162
95.	—— flexuosa, Schk.	X. p. 40
	—— *tenuis*, Rudge,	
	—— *debilis*, Mx.	
96.	—— sylvatica, Huds.	X. p. 40
	—— *drymeja*, Wahl.	
97.	—— digitalis, Muh.	XI. p. 147
98.	—— castanea, Wahl.	IX. p. 73
	—— *flexilis*, Rudge.	
99.	—— Washingtoniana, Dewey,	X. p. 272. tab. D fig. 14
	—— *nigra*, Schw. and Torrey.	
100.	—— tetanica, Schk.	XI. p. 312. tab. N fig. 49
101.	—— Halseyana, Dewey	XI. p. 313. tab. N fig. 43

3. *Pistillate spikes pedunculate and scarcely sheathed.*

102.	—— miliacea, Muh.	X. p. 30
	—— *prasina*, Wahl.	
103.	—— umbellata, Schk.	X. p. 31
	β. vicina, Dewey,	XI. p. 317 & X. tab. D. fig. 13
104.	—— miliaris, Mx.	X. p. 36
105.	—— pallescens,* L.	VII. p. 267
106.	—— Elliottii, Torrey,	XI. p. 151. tab. M fig. 40
	—— *castanea*, Elliott.	
	—— *fulva*, Muh.	
107.	—— hystericina, Willd.	X. p. 35
108.	—— glaucescens, Elliott.	XI. p. 150. tab. M fig. 39
	—— *sempervirens*, Schw.	
109.	—— limosa,* L.	X. p. 41
	β. irrigua, Wahl.	
	γ. rariflora, Wahl.	
	δ. livida, Wahl.	
	ε. oblonga, Dewey,	
	—— *lenticularis*, Mx.	VII. p. 273. & IX. tab. A fig. 2
110.	—— pseudo-cyperus,* L.	IX. p. 71
	—— *furcata*, Elliott.	
111.	—— Hitchcockiana, Dewey,	X. p. 274. tab. E fig. 17

H. *Staminate spikes two or more.*

112.	—— trichocarpa, Muh.	VII. p. 274. & XI. p. 152

	—— *β. turbinata*, Dewey,	XI. p. 159. tab. M fig. 42
113.	—— Barrattii, Torrey.	XI. p. 162
	—— *littoralis*, Schw.	
114.	—— aristata, R. Br.	XI. p. 161
115.	—— filiformis,* Gooden.	VII. p. 268
	—— *lanuginosa*, Mx.	
116.	—— ampullacea,* Gooden.	VII. p. 266
117.	—— vesicaria,* L.	X. p. 273
118.	—— verrucosa, Muh.	XI. p. 159. tab. M fig. 41
119.	—— bullata, Schk.	IX. p. 71
	—— β. cylindracea, Dewey,	XI. p. 315
120.	—— Schweinitzii, Dewey,	IX. p. 68. tab. B fig. 8
121.	—— retrorsa, Schw.	IX. p. 67. & XI tab. L fig. 36
	—— *Torreyana*, Schw.	
122.	—— pellita, Muh.	IX. p. 70
	—— *striata*, Mx.	
123.	—— lacustris,* Willd.	X. p. 43
	—— *riparia*, Muh.	
124.	—— verna, Vill. Pers.	XI. p. 314
125.	—— cherokeensis, Schw.	XI. p. 160. tab. L fig. 34
	—— *recurva*, Muh.	
126.	—— oligosperma, Mx.	XI. p. 160
127.	—— longirostris, Torrey,	IX. p. 257. tab. C fig. 10
128.	—— gigantea, Rudge,	XI. p. 164

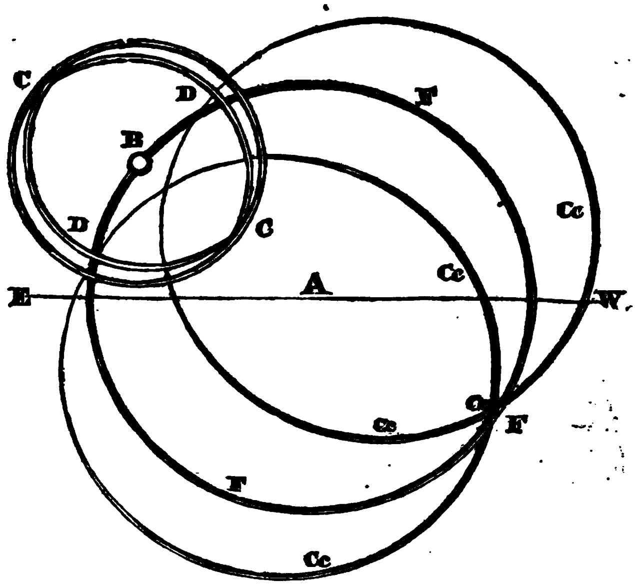
Note. An appendix, containing some additions, may be expected at a future day.

Art. XII.—*History and description of some remarkable Atmospheric Appearances, as they were observed on the 19th of August*, 1825; in a letter from Charles Meriwether, Esq. of Tod county, Ky. to Dr. Samuel L. Mitchill, dated Sept. 9, 1824.

Dear Sir,—

I have taken the liberty to send you an account of a phenomenon, so uncommon, that I think it would be proper to be inserted in some publication which may hand it down to posterity.

On Friday, the 19th of August, there appeared circles in the atmosphere, as laid down in the following diagram:



E and W represent the east and west point of the heavens; A is the zenith; B the sun; CC a prismatic circle, of surprising brilliancy; F a very bright circle of light, passing through the sun B; Cc Cc two sections of circles, intersecting the circle F, at the point Cc F. These sections were very bright at their intersection with F, but became gradually invisible as they approached the sun. B and A and Cc F were in a right line, and the intersection Cc F was the same height above the horzon as the sun, and moved north, and approached the zenith in the same proportion as the sun moved south and approached the zenith. The circle F and the sections Cc Cc were circles of similar radii, and diminished in size, as the sun approached the zenith. These circles were first observed about 8 o'clock, and continued until 11. There was not a cloud to be seen, but so thick a haze, high up in the atmosphere, that the sky appeared completely black, and the sun shone with so much splendor, and there was such a glare, that any person's eyes would be filled with tears in a few minutes, by going into the light.

The same phenomena appeared again on the following Friday. The haze was not so thick, and there were a few thin clouds floating in the atmosphere which, when they pass-

ed under any of the circles, obscured them until they were gone by. There appeared also on this day a prismatic oval at D D, but less brilliant than the external one; the day was less bright and the circles were less splendid. It was seen on this day from 9 o'clock in the forenoon until 1 in the evening, at which time the intersection was to the east of north; in all other respects the phenomena were the same as on the 19th.

In connexion with the above, it may be proper to add, that the weather this year has been rather uncommon in this neighborhood. Our winter was very dry and warm, and the summer more hot than any person in this part of the country recollects ever to have felt.* We have not had sufficient rain since the 20th of April, for transplanting, and not so much since the last of June as would lay the dust; and last night we had a frost sufficiently severe to kill some cucumbers we had kept alive by watering. About five days previous to the 19th, the wind shifted to the north-east, and remained there until after the 26th.

I have been thus particular in describing the weather, to enable you to form a rational explication of these phenomena. If you should consider the above as worthy of your attention, I shall be highly gratified; and, with the greatest respect, I beg leave to subscribe myself your most obedient servant. CHARLES MERIWETHER.

TO CHARLES MERIWETHER, ESQ.

New-York, March 13, 1825.

DEAR SIR,—

Your letter describing the meteorological phenomena, of August 19, and the succeeding Friday, as they were observed in your part of Kentucky, reached me, in due course, through the post-office.

I suppose they must be classed among the halos and parhelions; though it is my opinion a better theory is wanted than we yet possess, for their solution.

To preserve from oblivion, an atmospherical appearance of a somewhat similar nature, I described and figured, in the Medical Repository, vol. V. pp. 210-11, the three rainbows, which appeared at once, on the 17th October, 1801, and

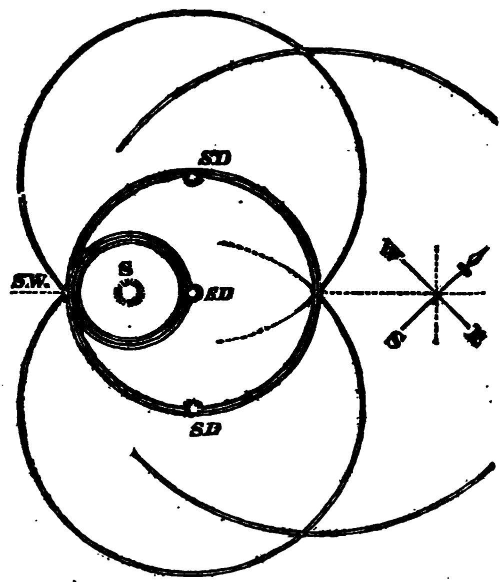
*Having had my thermometer broken, I am not able to gives the degrees.

quoted Musschenbroeck and Halley for elucidation: and with the like intention, I also noticed and delineated for the same work, vol. X. pp. 409-10, the very admirable meteors seen at New-York, on the 30th March, 1807. By consulting the passages referred to, you will find I have not been inattentive to such natural occurrences. It is my intention to offer your paper to our Literary and Philosophical Society, at their next meeting; and to submit its contents to their learned and scientific decision.

Your's, respectfully,

SAMUEL L. MITCHILL.

Delineation of halos which appeared about the sun on the 8th of September, 1816—continuance about one hour, (from 2 to 3 o'clock, P. M.) at Newport, R. I.—observed and delineated by D. MELVILLE.



Solar Halos.

Prefixed to the following article, in the Rhode Island paper, from which we copy it, is the paragraph published in the National Intelligencer of September 11, announcing the

phenomenon as seen in that city. We have thought this particular account of it, as observed elsewhere, would be acceptable to our readers.

[From the R. I. Republican.]

The above described phenomenon was observed at this place on the same day, Sunday, Sept. 8th, between the hours of two and three in the afternoon; duration of its appearance about 40 or 50 minutes. The annexed sketch was delineated at the time by actual observation.

The sun at that hour bearing about south west. The halo immediately encircling the sun was about the usual diameter of those commonly seen, but uncommonly bright, being tinged in its whole circumference with prismatic colours, especially on its upper and north-eastern limb, where a bright mock sun (or sun dog, as it is usually called by seamen) was formed; the rays of light from which, formed a second halo of a *smoky white* colour, well defined in its whole circumference, but more faintly as it approached the primary halo on its south-western limb, where they united, the second being exactly double the diameter of the first; this second circle having a mock sun, less bright than the first, on its north-western, and another on its south-eastern limb, on a right line, nearly in that direction from the one in the primary halo; the ray of light thrown off from which, formed two other circles, double the diameter of the second, and crossing the primary halo on its south-western limb, in the brilliancy of which it was lost; and crossing the second halo on its north-eastern limb about thirty degrees from the horizon, where they were well defined, but diminished into slight pencils, until they were lost as they approached the north-eastern part of the primary halo. The rays of light thrown off from the concentration of these circles at their junction, or place of crossing the north-east, formed another and larger circle, (about 120 degrees of which was below the horizon) which crossed the two last in faint lines, and lost itself as it approached the second circle, which it would have touched, if continued on its south-western limb.

It would be presumption in the writer to attempt accounting for the causes of a phenomenon in nature, which has remained unaccounted for by the philosophers of the present and preceding ages; but it will not be considered presumption to premise the causes of a phenomenon, which can-

ses are so self-evident as to have been considered unworthy the notice of the Newtons and Franklins and Rittenhouses that have gone before us. Halos or circles, around the sun or moon, have always been considered as the precursors of rain (or snow in the winter season) and all are accustomed to predict the number of hours to elapse before falling weather. by the number of stars visible within a circle about the moon.

The rainbow is formed by the reflection and refraction of the sun's rays on the falling globular particles of rain. Halos about the sun or moon are formed by the refraction of the rays of light on a medium more dense than the atmosphere, without any reflection as in the rainbow.

For six or eight weeks previous to the appearance of the phenomenon just described, very little rain had fallen on any part of this continent; as far as we have heard, the drought was general.

To account for the phenomenon as it appeared here, let us suppose the atmosphere to be abundantly charged with vapor taken up by the sun, but not yet formed into clouds of sufficient density to fall in rain, but of a density sufficient to cause a refraction of the sun's rays in their passage through it. Let us also suppose a north-easter commencing, (which was observed by Dr. Franklin always to commence in the south-west,) forming a counter current in the higher regions of the atmosphere, carrying the dense vapor with it from the S. W. to the N. E. And let us suppose also the most dense part of the volume of vapor to extend from the S. E. to the N. W. Then the rays of the sun, being refracted in their passage through this dense medium, would form the primary halo, with prismatic colors proportioned to the density of the medium, and the intensity of his rays—the most dense part of the medium or surrounding vapour causing a concentration of the sun's rays on that part, forming a mock sun, or sun-dog; the rays of light thrown off from which would form the second circle on the surrounding vapor. The same cause would occasion a concentration of the rays of light forming mock suns nearly on a right line N. W. and S. E. on the second circle, from the mock sun on the northeastern limb of the primary halo; the rays of light thrown off from which would form the two circles of the third order, of double the diameter of the second, which circles crossing the secondary halo on the northeastern part, forming anoth-

er concentration of the rays of light, which being again thrown off on the more distant and less dense medium, would form the great circle, extending below the horizon in the N. E. and crossing the third circles in a direction, if continued, to meet at the southwestern limb of the primary halo.

That these are the causes of those wonderful phenomena seems confirmed by the north-east gale that followed, commencing on Monday evening, and by the abundance of rain which has since fallen. At this place the rain commenced on the 9th, at night, and fell in torrents, almost without intermission, for eight days in succession. A.

[From the National Intelligencer.]

Extracts of a letter from Dr. S. L. Mitchill, dated October 4, 1816.—"I thank you for your account of the halo of September 8, accompanied with a drawing. Under a conviction that such natural appearances ought to be recorded for the benefit of the present time, and the information of our successors, I caused the most remarkable meteor of this kind that I ever beheld, to be delineated and preserved in the *Medical Repository*. In the 10th volume of that work, its history and figures may be seen; where, in addition to two *circles*, like those you observed, there were *five* parhelia, and two of them tailed.

"As to a theory of the colors which are produced by the reflection and refraction of light in the rainbow, it requires an alteration or modification to suit the case of *halos* and *parhelia.* I consider the scientific application of the laws of optics, to solve this phenomenon, as one of the most inviting subjects of modern science. It seems to be a *casus omissus* or *prætermissus* in the Newtonian doctrine. An ardent genius in our country might supply the *hiatus*."

I view the reasonings of "A," in the Rhode-Island Republican, republished in the National Intelligencer, Oct. 3, as being superior to any thing I have seen on this subject.

Washington City, Oct. 11.

[From the Philadelphia Register, Sept. 17, 1816.]

A description is given in the National Intelligencer, of the 12th inst. of a circle or halo, which was observed at Washington on the 8th Sept.—and as the writer is desirous of knowing the extent of this curious phenomenon, I shall attempt to describe it as it appeared in this vicinity.

Between 11 and 12 o'clock on Sunday, 8th Sept. a beautiful corona or halo, was seen at Holmesburg, near Philadelphia, around the sun. The diameter appeared about half the size of a rainbow, the rim or edge strongly marked with prismatic colours, and particularly a deep orange—the body of the circle was very misty; but on the outside a clear blue sky. To the northward of this, there was another complete circle, of about the like dimensions, intersecting the former, and passing through the centre of the sun, at its southern extremity. Intersecting this circle to the northward, were arcs of two other circles, of much larger dimensions, crossing each other—colour whitish, but fainter than the other. The sky was remarkably clear to the northward, cloudy towards the south. In a southerly direction, there was also observed, about one eighth part of a circle above the clouds, with very bright colours. L.

Extract of a letter from a young gentleman in New Castle, (Del.) to his sister in the city of New-York, dated Sept. 10th, 1816.—"On Sunday morning last, at about 11 o'clock, we were surprised by a most singular appearance of four circles on and about the sun's disk, each having perfect all the colours of the rainbow. One of them (the most brilliant) crossed the sun's centre—two each cut the centre of the first, and the fourth was connected and at some distance from the sun. Some of us are superstitious and frightened, and none of us can give a conjecture as to what has produced them."

WASHINGTON CITY, Sept. 25, 1816.

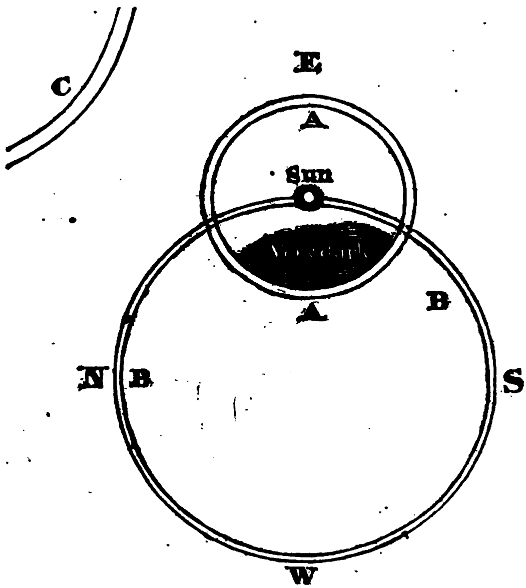
I have sketched an uncommon *halo* which I saw here. I think it is an opprobium to modern philosophy, that no satisfactory solution of the result of *reflection* and *refraction* has been given, at least I have seen none. It was seen at Philadelphia, and at Newcastle, Delaware—at the *last* place

with extraordinary modifications. No man is better able than you are to solve the phenomenon.

I have the honour to be, with esteem, and very respectfully yours,

JOSIAH MEIGS.

The Hon. S. L. MITCHILL, New-York.



ART. XIII.—*On Pitch-back and Breast-Wheels.* By Mr. A. B. QUINBY.

PROF. SILLIMAN,

DEAR SIR,—In my letter of Feb. 12, 1825, I promised to communicate a paper for a subsequent number of this Journal, applying my theory of the Overshot-Water-Wheel to the Pitch-back and Breast-Wheels. I now redeem that pledge.

Before offering my present paper, however, it is proper to remark, that a Pitch-back-Water-Wheel is one that receives the water at any point between the top of the wheel and the

lower extremity of the first quadrant: and that a Breast-Wheel is one that receives the water exactly at the lower extremity of the first quadrant.* It is demonstrated in my paper on the Overshot-Water-Wheel, that the *effect* of water in descending upon the circumference of a wheel, is always in proportion to the vertical space passed through.

This fact being regarded, it is easy to apply the theory of the Overshot-Water-Wheel to the Pitch-back and Breast-Wheels.

If we assume the condition that the water is delivered upon the wheel with a velocity equal to that of the circumference of the wheel, (in practice the water should be delivered upon the wheel with a velocity a little exceeding that of the circumference of the wheel,) then there is no difference in principle between the Overshot-Water-Wheel, and the Pitch-back and the Breast-Wheel; the *effect* of any quantity of water descending upon either wheel, being always in proportion to the vertical space passed through—and being always measured by the quantity of water expended, multiplied into the vertical space through which it descends upon the wheel.†

Having now given my theory on the subject of the Overshot Water-Wheel, the Pitch-back and the Breast-Wheel, I will add one remark on the subject of constructing these wheels.

Construct either wheel so that the water may descend upon it through as great a vertical space as possible—giving to the wheel, at the same time, the proper velocity.

I have forborne offering any remarks on the theory of the Undèrshot-Water-Wheel, as I have understood from my friend Prof. Robert Adrain, that he has a paper prepared for publication on that subject.

A. B. QUINBY.

August 7, 1826.

* I am aware that these definitions differ from those given by some authors; but I think the meaning of the word Pitch-back requires the definition I have given of that wheel; and this definition being adopted, the definition I have given of the Breast-wheel, follows. The definitions, however, are matters of but little importance.

† Friction is here not regarded.

Rejoinder to the writer of the article in the North American Review.

TO THE EDITOR.

SIR,

The reason that has caused my delay in answering the Rejoinder of the writer of the article in the North American Review, need not be stated to the public.

The question between the writer of the Review and myself, "is very narrow." I had stated in Vol. VII. of this Journal, that "The North American Review contains an article in which it is stated that the *crank* occasions a loss of *three-fourths* of the whole power employed!!"

I then quoted the Review, as follows:

"There is in the steam engine a loss of power *in changing the direction of its action;* from rectilinear to rotary, *by the methods in common practice*, not very satisfactorily accounted for, considering the magnitude of the loss, which on an average amounts to about *three-fourths* of the whole power, as [which] appears from the reports of the performance of the engines used at the mines in Cornwall." I then added, that, "With respect to the reports of the performance of the engines used at the mines in Cornwall I had no knowledge, and was, therefore, not able to refer to the authority by which they were made out." "It must, however, be concluded, that a very great blunder has, in some way, been committed by those who made the estimates, since the rotary motion produced by the *crank*, does not, in truth, (abstractly considered,) occasion any loss whatever of the acting power."

These remarks drew from the writer of the Review a reply, charging me with "misrepresentation;" and denying that, "any one can pretend for one moment that there is any thing in his paragraph which warrants Mr. Quinby's assertion that the loss of power is *supposed to result* from the *crank*."

I then wrote a reply, and endeavored to convince the writer of the article in question, that the paragraph I had quoted *does* warrant my assertion that the loss of power is *supposed to result* from the *crank*. But this did not do. The writer of the Review published a rejoinder—and this I shall now briefly answer.

To justify the strictures I offered, it is only necessary to attend to the construction of the paragraph quoted.

In this paragraph it is asserted that, "There is in the steam engine a loss of power, *in changing the direction of its action* from rectilinear to rotary *by the method in common practice.*" This is the first member of the sentence. The two next members are not necessary in the examination. The fourth member expresses, "Which on an average amounts to about *three-fourths* of the whole power;" And then the author appends the following member. "As [which] appears from the reports of the performance of the engines used at the mines in Cornwall." Now, in *this* sentence, how much does the author assert on his own responsibility? and how much does he give on the authority of Messrs. Leans? This can readily be determined by *parsing* the *pronoun* as, [which,] which has for its antecedent the member, "Which, on an average, amounts to about *three-fourths* of the whole power." Hence it is what is expressed in this member that "*appears* from the reports of the performance of the engines used at the mines in Cornwall."* And therefore the part that is given by the author on the authority of Messrs. Leans, is merely that which relates to the *quantity* of the loss; and all that is expressed in the preceding part of the sentence, which declares that, "There is in the steam engine a loss of power," &c. is asserted by the author on his own responsibility; and he must be considered the accountable author of his own production.

I shall now come to a different part of the subject. In the rejoinder the author says, "I had stated that there was, in the steam-engine, a loss of power in changing the direction of its action from rectilinear to rotary, by the methods in common practice, *, *, *, as [which] appears from the reports of the performance of the engines used at the mines in Cornwall."

Now, it is asked, why did the writer of this rejoinder, and of the article in the North American Review, leave out these three interposing members of this sentence? Did he think the reader so little informed as not to be able to perceive the

* I do not believe that any such thing *appears* from Messrs. Lean's reports. And I wish it understood that I merely *admit* the fact for the sake of putting the point in the most favourable shape for the writer of the article in the North American Review.

difference between what he has here given and the original sentence? But the reason is plain. He knew the original sentence fixes the responsibility upon himself; and that by leaving out the three interposing members, he could shift the responsibility upon Messrs. T. & J. Lean.*

I shall now take some notice of the insinuation of the writer of the article in the North American Review, that "there is nothing *new* in my demonstration."

Had the writer of this article been acquainted with the principles of the *crank problem;* or had he understood my demonstration; he would not have made so unfounded an insinuation.

The next subject to be noticed, is the assertion that, "The crank is, in any position, *merely the arm of a lever,* capable only of modifying force without destroying it; a fact known sometime before Mr. Quinby's demonstration of the *crank problem*, namely, in the age of Archimedes."

"The *crank* is, in any position, *merely the arm of a lever.*" This is precisely the error committed by Mr. Ward, and by O. W. in the London Journal of Arts and Sciences, in their attempts to solve the *crank problem.*

In the lever, the *direction* of the force is always the same, and the *intensity* always constant.

In the *crank*, the *direction* of the force varies *continually*, and the *intensity* is not, *for any portion of time*, constant.

If Archimedes considered the *crank* "*merely the arm of a lever*," it is sufficient proof that he knew nothing about the *problem.*

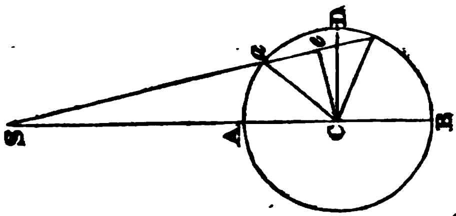
I shall now conclude this reply by expressing my regret that a subject so exceedingly plain should have occupied so much room in a scientific Journal.

The course I have adopted and pursued has appeared to me necessary, not only in reference to myself, but in reference to the public. A. B. Quinby.

August 5, 1826.

* By leaving out these three interposing members, the *first* member A becomes the antecedent of the pronoun, as [which.]

Art. XIV.—*Problem to determine the position of the Crank when the tendency of the power to produce rotation is a maximum.* By Mr. A. B. Quinby.*



Put P = power, $a = Sa$, $r = Ca$, and $x = Ce$,

Then, $\sqrt{r^2 - x^2} = ea$, $\sqrt{(a + \sqrt{r^2 - x^2})^2 + x^2} = SC$.

Now, by mechanics, the tendency of P to produce rotation $= P \times \frac{SC}{Se} \times Ce = P \times \frac{\sqrt{(a + \sqrt{r^2 - x^2})^2 + x^2}}{a + \sqrt{r^2 - x^2}} \times x$;

which is to be a maximum.

This expression being put into Fluxions, and equated $= 0$, the proper value of x can be found: and the proper value of x being had, the position of the *crank* is easily determined.

Note. If it were required to determine the two positions of the *crank* when the tendency of P to produce rotation is equal to the *mean* tendency, (from A to B) we should have the following expression:

$$P \times \frac{\sqrt{(a \pm \sqrt{r^2 - x^2})^2 + x^2}}{a \pm \sqrt{r^2 - x^2}} \times x = P \times \frac{r^2}{AD}\dagger$$

Or, since $P \times \frac{r^2}{AD}$ is a constant quantity, the same points can be de-

* This solution was written (and also wrought out) in 1821, at Newcastle, Del. and shown to Maj. Babcock and Lt. Brewerton, Corps of Engineers, U. S. Army.

† See my demonstration of the *crank problem*, Vol. VII. of this Journal.

† The sign + before the quantity $\sqrt{r^2 - x^2}$ gives the position in the upper quadrant: and the sign − before the same quantity, gives the position in the lower quadrant.

termined by putting $P \times \frac{\sqrt{(a \pm \sqrt{r^2 - x^2})^2 + x^2}}{a \pm \sqrt{r^2 - x^2}} \times x$ into Fluxions, and equating $= 0$. Hence we have a general expression for the three points.*

A. B. QUINBY.

August 4, 1826.

* The *shackle-bar* on board the steam-boat Chancellor Livingston, on the Hudson river, is 150 inches long, and the *crank* 30 inches. By applying the formulæ I have given, it is found that the power has the greatest tendency to produce rotation when the *crank* is 78° 26′ 41″ from the upper dead point. The angle made by the *crank* and *shackle-bar* at this time, is obtuse.

ART. XV.—*Preface to Experiments and application to Mechanical Industry of the upward force of Fluids.* (*Genet's Memorial.*) By FELIX PASCALIS, M. D., President of the American Branch of the Linnæan Society of Paris, &c. &c.

IT is often the case, in this age of much writing and printing, that Reviewers, or Editors of Journals, have the exclusive power to establish the reputation of an author, if they choose, or to deliver over his book to neglect and contempt. They may also raise a work much above its true merit and value. From this result there is not much harm, because public opinion must finally decide and award justice to the author. There is still a degree of retardation to the progress of science, of taste, or of other desirable improvements; but what is worse, is the fallen fortune of a book in the market. When it has once been lowered in the hands of wholesale or retailing venders, it never can be well restored; and what should command the sober and cautious attention of the readers, is, that they are themselves *duped*, in as much as not being aware of the comparative merits of the author and his reviewer, they take it for granted, that it is the duty of the latter to be impartial, while he is not even qualified to bestow either praise or censure.

To these observations I was led, by reading, lately, much incorrect criticism, and many unfounded remarks, against Mr. E. C. Genet's Memoir on the upward forces of Fluids,

on which I wrote something in the preceding number of this Journal. I hesitate, however, to be myself his encomiast, but I would rather be condemned to study again my experimental and mechanical philosophy, than to condemn any portion of it, much less his departure in part from the Newtonian philosophy. Have we not proofs enough in nature, that if there are many of its elements under centrifugal agency, there are others under a centripetal force?

We have still much to learn of the contending powers which sustain and govern the world; but if we compare the improvements in navigation, which have been made within the last thirty years, and which, by means of the steam power alone, surpass those of many centuries, we may infer that as much remains to be discovered in hydrodynamics, or in the laws governing the motion, the pressure and the force of other fluids. Nor should we be discouraged by the objection founded on the supposed impracticability of inventing appropriate and competent machinery. Would the machinery be more difficult than that which was necessary to enable the Romans to build their colliseum, and the Egyptians to erect their great pyramid?

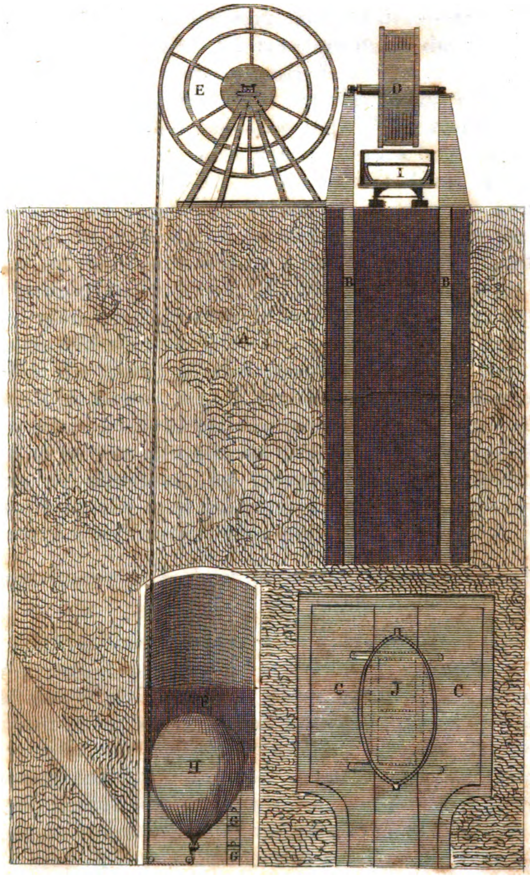
First Experiment,

Of an ærostatic elevator on a canal inclined plane and rail-way, rise of one foot to 15 in 120.

This is intended to raise or lower canal boats, whenever there is a solution of continuity, from the lower to the higher level. Having excavated a basin, plate A, fig. 1, double the depth of the canal, at the termination of the water level, a double rail-way on an inclined plane B is to be constructed, and on the top of the hill, two basins C on the plan of the dry dock, having side drains to discharge the water, without injuring the rail-way. Over that dry dock basin, may be constructed a spacious frame building, D, with a large cupola, the whole resting on a stone foundation, part of which shall be the outside walls of the basin, several feet higher than the loaded boats afloat. Under the cupola a pit is to be dug for the purpose of a laboratory.

The moving force of this machinery is to be essentially the ascensive force of an ærostat of a spheroidal form, which, when disengaged and allowed to ascend, will exercise its power on the large wheel, by means of a rope or chain fastened to its appendage O, that will pass through a sheave P

A *Hill*
B *Casement*
C *Basin*
D *Horizontal Drum*
E *Large vertical wheel*
F *Well*
G *Graduated eductive gates*
H *Hidrostat*
I *Boat on the platform*
J *Cradle to hoist the boats*



VIEW OF AN HYDROSTATIC VERTICAL-ELEVATOR, ON A CANAL.

at the bottom of the pit, to a groove on the rim of the large wheel, and embrace its circumference. The large wheel is supplied with hand spokes, to accelerate or retard its motion, or it is used separately, and also with a pall, to prevent the load from descending, whenever requisite. The large wheel is to be 30 feet in diameter, and 90 in circumference; which proportion will give 15 revolutions of the drum, while the large wheel will perform only 1.

The cupola therefore is intended to cover an ærostat, G, and allow it a definite ascension. The rest of the building is to cover the dry dock basins, and a large vertical wheel, H, connected to an horizontal axle or drum, I, to which are fastened two ropes or chains, J, in order to coil inversely, passing through the stout sheeve, K, under the drum. In each of the basins will be a car or cradle, L, supported by six pairs of tack screws, M, morticed in an under frame, resting upon wrought-iron axles, around which cast iron rail wheels will revolve, N.

For the theory of this ærostatic elevator, and the regulation of its power, which is also applied to lowering the boats to a water level, to raise or lower carriages or rail-ways, and also to relieve steam-boats stranded or grounded on shoals, bars, or alluvions, the upward lifts of an ærostat filled instantly by the coal gas, &c. we must refer the reader to the general work itself. (See plate No. 1.)

Experiments on hydrostatic power, and applications to various purposes.

An hydrostatic power is, in this case, that which is created by a certain quantity of atmospheric air inclosed in a vessel, and this is placed under a column of water, which embraces it, and being eight times heavier, acts in proportion to its perpendicular pressure, and must increase the repulsive and ascentional force of said vessel; in consequence of which fundamental law of nature, the author having experimented with an *hydroærostatometer*, of known dimensions and weight, has been able to regulate and produce the following

Comparative Table of Hydrostatic Forces.

Cubic foot of atmospheric air.	Fresh water.	Salt water.
1	100	108
10	1000	1080
20	2000	2160
30	3000	3240
40	4000	4320
50	5000	5400
60	6000	6480
70	7000	7560
80	8000	8640
90	9000	9720
100	10,000	10,800
200	20,000	21,600
300	30,000	32,400
400	40,000	43,200
500	50,000	54,000
600	60,000	64,800
700	70,000	75,600
800	80,000	86,400
900	90,000	97,200
1000	100,000	108,200

This power is to be applied, 1st, to raise or lower, vertically, canal boats to a high altitude; 2d, to relieve canal boats or steam-boats, arrested in their course by breaches, shallow water, or deposits of mud and other substances; 3d, to raise vessels stranded, foul anchors, snags, planters, &c. and to raise vertically heavy weights on the water and on the land; 4th, to prevent ships and vessels from sinking and men from drowning. It is for these important objects that two kinds of hydrostats are proposed; one is a vertical elevator on a canal, and the other is a tractor horizontal, and may be vertical, too, as the following diagrams can better exhibit to an attentive reader.

Hydrostatic Elevator—(Vid. plate 2.)

It is an indispensable requisite, that water can be procured from any convenient place, above the level of the water below, when the most perpendicular part of a hill is to be cut or straitened vertically, and to resist any pressure, this A should be also strengthened by retaining walls if necessary:

a casement B wider than the larger boat, must be built, either in wood or stone, and at its base a basin C will be excavated lower than the water level of the canal, in order to receive the cradle upon which the boats are to be raised or lowered down.

The said basin should of course be calculated to hold water enough to float the boats over the cradles, J; lift chains are fastened to this, right and left to the walls of the casement, and embrace the cradle and the boat at a common centre, where they will be hooked, and the whole weight raised or lowered according to the route pursued by the boat. The cradles will be protected to prevent strong friction against the walls with fixed rollers, or with small truck wheels revolving on very strong axles.

It is now very well understood that this double strong lift chain is to coil round a drum, extending over the whole casement; that the drum will be coupled, as said before, to a large vertical wheel, E, 30 feet in diameter, and that contiguous to the lower basin, and higher than its level, will be constructed a well, F, in the ground or above; and on the sides of the well will be graduated eductive gates to discharge the water, G. At the bottom of the well will be fastened a strong sheave or roller, and through this will run a chain, extending from the hydrostat H, and moving power and force, up to the rim of the periphery of the large wheel, above where it will terminate and be fastened. If the lift is 100 feet perpendicular, an ascension of ten feet in the well performed by the hydrostat, and a revolution of ten feet of the large wheel, will accomplish it, and place the boat and cradle, I, on the platform.

Third Experiment.

Of hydrostatic tractors to be established on a canal line.

On a strong scow, 20 feet square, A plate III, fig. 1, 2, brought close to the deposit or impediment, and partly supported by it, is a cistern, B, with a sliding gate, C, to admit or exclude water. In that cistern is an adapted hydrostat, D, with a rack rod, E the teeth of which drive two segments of cog wheels, vibrating on the same centre, F, differing in size; the small one of the rack rod is a segment of a wheel, 12 feet in diameter, and the large one of a wheel eighteen feet in diameter. This meshes into a small cog wheel, G, adapted to a drum 20 feet in diameter, H, on which is coiled

the cable or chain to the boat, I, on ground behind the canal, J. At each corner of the scow, are strong braces, K, to steady her against the banks of the canal, L. Mr. G. calculates that an ordinary canal boat of 30 tons, lightened of part of her cargo, would require an hydrostat of 11 feet diameter, containing 600 cubic feet of air; but if the boat be much lightened, the machine could be reduced accordingly. In addition, however, to the power of the tractors, there is a method, which would immediately save that trouble, and which was practised in Russia, to transport from the swamps of Finland to St. Petersburg, the immense rock of granite, on which now stands the equestrian statue of Peter the First. These means would be a set of planks, M, fig. 2, with two long pieces of timber, bored like gutters, and a certain number of cannon balls to suit, and having laid planks crosswise, the boat might be drawn over, and the draft rendered much easier.

To accomplish the objects enumerated under the third specification, Mr. G. substitutes different mechanical means for the hydrostatic tractor, that is, a crane, N, fig. 3, which vertical force is much superior to that of horses and men.

FOURTH EXPERIMENT,
Or application of the hydrostatic and ærostatic powers to aquatic navigation.

This subject is introduced by a minute and very descriptive comparison with the steam power. "But how is motion "created and transmitted to the paddles, with the same velo-"city, by the hydrostat as by the steam? By the alternate "increase and decrease of temperature which produces in "the cylinder two kinds of fluids, the one gaseous, the other "atmospheric,* by the means of which the piston rises "and falls. So far the originators of force and motion are "alike, and nothing more remains to be explained, but the "mechanical arrangement and regulations which will or-"ganise an hydrostatic ship; an *hydronaut*, with a velocity "and uniformity of action superior to the best and most "powerful steam-boat engine."

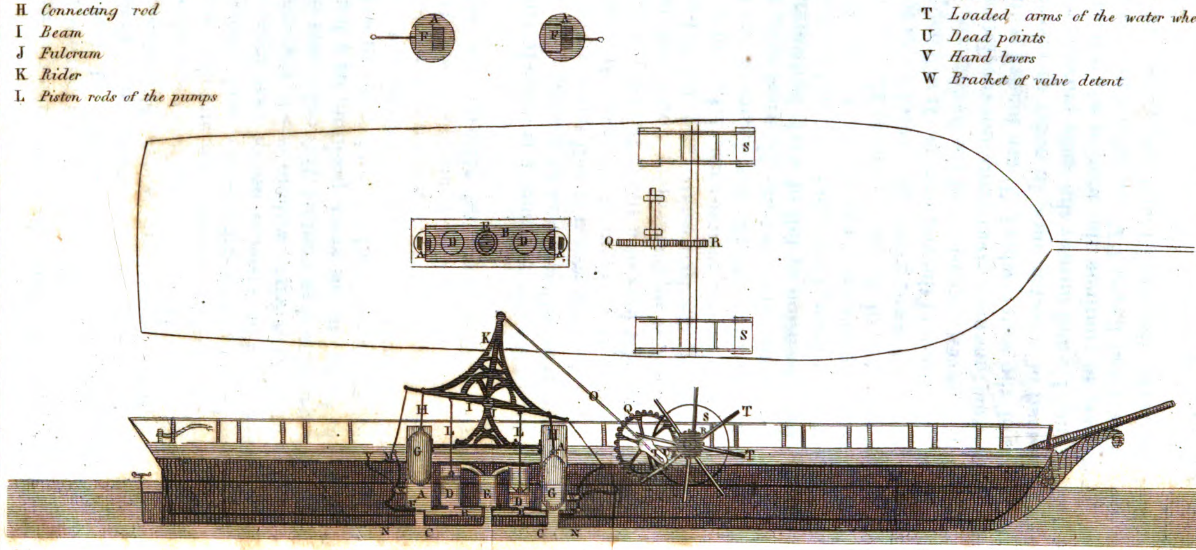
Two cisterns, AA, of which three views are offered in plate 4, are constructed over the recipient B, one foot lower than these; which should contain each 48 cubic feet of wa-

* In the steam machinery; or by immersing an hydrostat alternately in two different fluids, air and water, in our hydronaut!

Pla. 4th

A *Cisterns*
B *Recipient*
C *Line between the recipient and the charging valve*
D *Air pumps*
E *Sink*
F *Slide valves*
G *Hydrostats*
H *Connecting rod*
I *Beam*
J *Fulcrum*
K *Rider*
L *Piston rods of the pumps*

M *Valve regulators*
N *Valve detent*
O *Connecting bar*
P *Crank*
Q *Cog wheel*
R *Pinion*
S *Water wheel*
T *Loaded arms of the water wheel*
U *Dead points*
V *Hand levers*
W *Bracket of valve detent*



HYDROSTATIC VESSEL OR HYDRONAUT

ter, as far up as the water line; half the quantity, therefore, of all the water in the reservoir, which extends to the line C. This communicates with the trunks of two powerful air pumps, DD, from which the water raised by their suction will flow in a constant stream into a sink, E, entirely open to the main water under the vessel. Below each cistern are slide valves, FF, regulated so as to open and shut at proper intervals, immediately discharging water, and cutting off the external waters. The cisterns are of cast iron, open ended, and each fitted to receive, without much friction, the hydrostats, GG, calculated to contain 160 cubic feet of air or gas, and which, being in an erect position, as a long spheroid, made of copper, braced and soldered, alike in weight and capacity, will be calculated to receive on the surface of their inferior hemisphere, the forcing pressure of the intruding water, and to support a strong connecting rod, HH, fastened to the hydrostat by a joint, and affixed to the beam, I, by a similar joint.

So far this hydraulic machinery is entirely ruled by that beam, 24 feet long, of iron, and supported at its centre by a strong fulcrum, J, upon which it will move according to the upward force that is to make it vibrate. It bears, also, on each of its arms, the legs of a rider, K, 14 feet high, to each of which is affixed a supplementary rod; and between the connecting rod of the hydrostats and the fulcrum of the beam, are affixed the two piston-rods, LL, and at the end of the supplementary rods, are the regulators of the valves, M, which by the means of a detent, N, must open or shut according to the ascension or fall of each hydrostat. The rider, therefore, is a lever, imparting motion by a bar, O, to a crank, P, which plays on a cog wheel, Q, and the said cog wheel, by the means of a small pinion, R, fastened on the centre of the wheel shaft, gives three revolutions to the water wheel, S, against one of the cog wheels. It will happen, therefore, that from seven ascensions of the hydrostats, the water wheel in the same time must give twenty-one revolutions. Three of the arms of the water wheel, T are loaded with cast iron buckets, instead of wooden ones, in order to counterbalance the dead point, U, and answer the same purpose as the arms of a fly wheel, to continue the motion when the power decreases. Two hand levers VV are affixed to a small bucket, W, that supports the detent and regulators of the slide valves.

Thus goes the machinery, by one man lowering one of these levers and opening one of these valves. A sudden irruption of water takes place below; an hydrostat ascends; the movement is transferred to the water wheels, assisted by the weight of the iron buckets; the crank is compelled to turn, &c. So the hydronaut will be navigated until it is stopped. (Vid. p. 65, 66.)

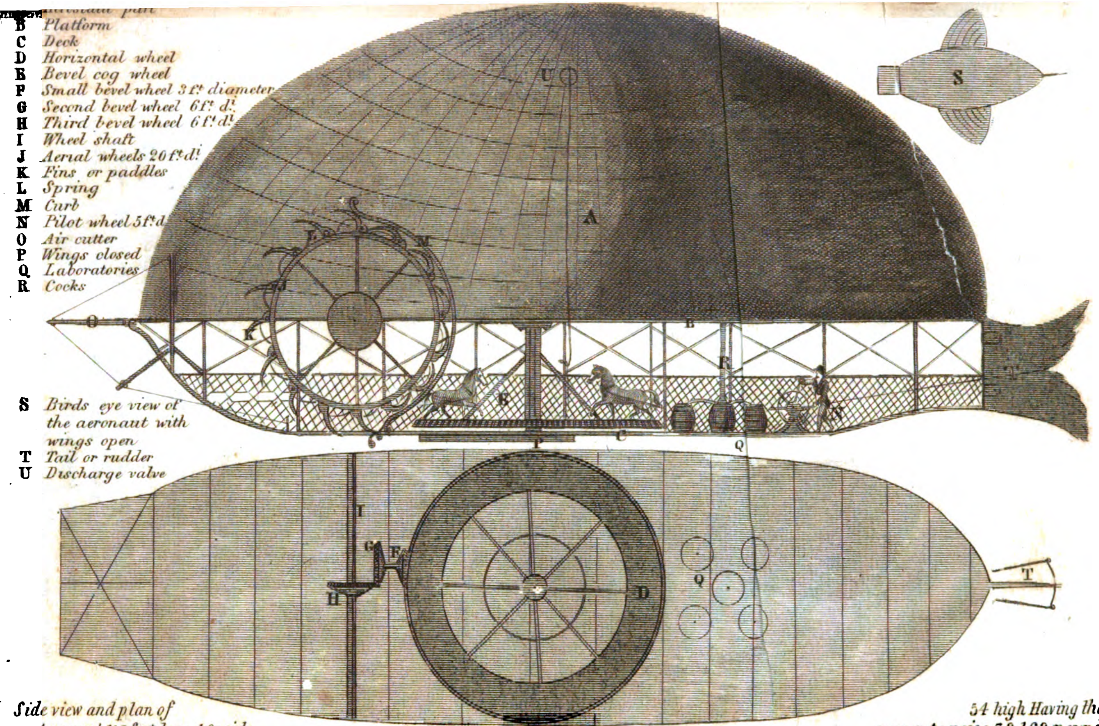
Fifth Experiment,

Or application of the upwards ærostatic forces to æronautics.

This is the last but most complicated of the inventions here exhibited. On its hazards and dangers the author remarks, "that he has given up all the benefits which might result for æronautics from the great alliance of fire and water, or the combustion of gases, to procure a vacuum, and that he has found substitutes, affording the same results, with less danger, expense and weight."

We pass over his analysis of the mechanic organic power, by which the birds fly and the fish swim; perhaps his machine will approximate as near to the effects of their curious organization, as human ingenuity can go. He gives us an elliptic hemisphere only of a large balloon, (A, plate 5,) that he may the more effectually cause its form to approach to that of a fish. Having an area of 54 feet, and being filled with hydrogen, it will contain a million and twenty-three thousand cubic feet of that gas, and will carry a burden of 37 tons.

The cover and netting of the ærostat are fastened to a platform, B, all glazed and lined with oiled silk, and to this hangs a deck, C, of the same dimensions, and of the form of a fish. On its centre is constructed an horizontal wheel, D, 23 feet in diameter, that is framed to an upright shaft, the upper end of which moves in a box fastened to the platform, and the lower in a socket fixed in the deck. Two horses can stand upon the wheel, and being yoked to posts standing unconnected upon that wheel, they compel it to revolve forward by the action of their legs, and the weight of their bodies. On the periphery of the wheel, are bevel cogs, E, which mesh into a small bevel wheel, F, 3 feet in diameter; this meshes into another bevel, wheel, G, 6 feet, diameter; and this also into another, H, which being fastened on the shaft, I, must cause the two lateral aerial wheels, J, 20 feet in diameter to revolve twenty-one times in one minute, with a velocity of 2160 feet. This is the great directing power of the æronaut, because



Side view and plan of an Aeronaut 152 feet long 46 wide 54 high Having the power to raise 73 162 pounds

AEROSTATIC VESSEL OR AERONAUT

like the wings of a bird, or the fins of a fish, they exercise a perpendicular and backward pressure by their form and construction. These wheels are indeed like an expanded wing or fin, K, when one half of them fastened to their axles by hinges, and liberated from a case, are acted on by a circular spring, L, they are compelled to expand a surface of 100 square feet. The force and power of which in comparison with the incumbent weight and contingencies we now omit.

But there are two other powers necessary to complete the analogy with birds and fish; the one is in the head, the other in the tail. Inverting a little the order in which the author has described them, we will then say, that in imitation of the first, which with their neck and sharp bills, and of the other, which with their angular mouths, go where they please, he has provided the æronaut, 1st, with an air cutter, hanging to hinges, O, in due length and breadth, and which may be raised or lowered by cords in pulleys, to describe either an ascending, lowering, or horizontal line; and, 2d, with a tail, or a rudder, not only to steer the machine, but also to supply it with an additional force of propulsion, by the means of an oscillatory motion, like that of sculling a boat. This is procured by a pilot wheel, N, turning over a barrel, &c.; or, according to very well known methods.

But this is not all; when birds want to alight they pause, or turn round, extending their wings very much to prevent too sudden a fall; and then, contracting more or less one or the other wing, they alight exactly where they please. How this nice faculty is imparted to the æronaut, we will describe. It is by means of two leeboards, or wings, P, 22 feet in width and 12 in length, fastened under deck by a ring and bolt, moving within semicircular staples, and which may be hauled in and out by two ropes running through sheeves. These wings could also serve as parachutes, if the ærostat should burst, and they may answer many obvious and excellent purposes.

At each end of the deck, are two laboratories, Q, to supply the gas requisite to replenish the ærostat by the stopcocks, R; the rest of the space is to be employed for the accommodation of freight and passengers. T, is the rudder or tail, and U, the discharge valve for the gas.

Thus far we have succinctly described the æronaut of Mr. Genet, offering at the same time a view of all his plates. We

are satisfied of the novelty and ingenuity he has displayed in each of his experiments and applications, but this remark is particularly applicable to the part upon which it may be said, that the whole labour of theorists and machinists has been during nearly 60 years concentrated, to find out themeans of directing and regulating the course of a balloon after it is launched in the atmosphere. We have abstained from the privilege of reviewers, who might have caught some cause of censure and criticism, although we are aware of a few inaccuracies, and of some material objections that might be offered against the theories of the author, as well as with respect to his mechanical applications. We think it better and more honourable to keep these under consideration, until he can avail himself of a farther revisal, and until the public opinion may have had a proper chance to be formed. There is no doubt but a sufficient number of qualified *judges* and experimenters may be found in this country, where mechanical pursuits and ingenuity are so often successfully applied to public improvements. A different course would appear to us exceptionable, inasmuch as Mr. Genet is not a philosopher of common stamp; nor has he departed from any principle in hydrostatics or in dynamics, that could not be supported, even with some exception to the Newtonian law of gravitation. The right of a patent which Mr. Genet has affixed to his discovery, will sufficiently protect him against any improper invasion, as well as the public mind against any dangerous error or application that could be apprehended from his speculations, and we should add, against unqualified witticism pointing at ridicule, or condemning his memorial to be dead stock in the booksellers' shops. "Quæque ipse miserrima vidi."

ART. XVI.—*On the present state of Chemical Science.* By DENISON OLMSTED, Professor of Mathematics and Natural Philosophy in Yale College.*

(Read before the Connecticut Academy of Arts and Sciences, Sept. 5, 1826.)

So rapid has been the progress of chemical science during the last ten or fifteen years, that our elder scholars frequently complain, that it has passed almost out of their field of view. It is the object of the present paper to offer a sketch of the science, according to its latest physiognomy; more especially of those features, which have of late so materially altered its complexion. But, before we proceed to the enumeration of those noble and interesting contributions, which have recently been made to this department of knowledge, let us take a brief survey of the logic of chemistry, the improvements in which do not appear to have kept pace with the march of discovery. Although the field of experimental chemistry, has been crowded with ardent votaries, and although every corner of it has been hunted by competitors eager for discovery, the philosophy of chemistry appears not to have been cultivated with equal zeal or ability. We still need a Locke to settle the metaphysics of the science, and to give simplicity and precision to its reasonings. Its very definition is so far from being agreed on, that every new elementary work offers a new one, differing more or less from all that have preceded it; and it is still the most puzzling thing to the chemist to tell, *what is chemistry?* It is evidently required of a good definition to be discriminating and descriptive;—to prevent the science to which it relates, from being confounded with any other, and to convey as much information, as is possible within so small a compass, respecting its own nature. The greater number of the definitions of chemistry, err in not being sufficiently descriptive. Thus Dr. Thomson defines chemistry to be, *the science which treats of those events and changes in natural bodies, which are not accompanied by sensible motion.* This definition may seem to distinguish chemistry from mechanical philosophy, but it gives us very little information respecting the appropriate business of the chemist. It is apt, moreover, to lead the beginner into misapprehension; as whenever he perceives mo-

* Late Professor of Chemistry in the University of North-Carolina.

tion in the action of substances on each other, he will infer that the action is not chemical, whereas the greater number of cases of combination, are attended with more or less of sensible motion. Thus, when we pour nitric acid on chalk, a violent effervescence ensues. Is the phenomenon therefore not chemical? The motion is, indeed, mechanical. It arises from an elastic substance, (carbonic acid,) making its way through the fluid; while all that is strictly chemical, namely, the union of the particles of the acid with those of the lime, is, it is true, imperceptible. Still it is *accompanied by* a sensible motion; and the student must have made considerable proficiency in the science, before he will be able to make the necessary distinction. The definition, which appears to me to convey to the learner the clearest views of the peculiar province of the chemist, is that which represents him as occupied with the changes which take place among the particles of matter, in distinction from masses,—as employed in resolving compound substances into their elements, and uniting simples into compounds. When a new substance is presented to him, his first inquiry is, *is it simple or compound?* and his second is, what changes is it capable of effecting in other chemical agents, or of sustaining from them? as whether it is fusible by heat, or soluble in an acid. If he can resolve it into two substances, he proceeds next to ascertain the peculiar properties and relations of each of these, by investigating, as was done with the compound, the changes it is capable of effecting in other chemical agents, or of sustaining from them. Hence, the following definition appears to me to express as much of these peculiarities of the science, as is capable of being comprehended in so short a space.

*Chemistry investigates the composition of bodies, and the changes of constitution, which they produce by their action on each other.** If any fault can be found with this definition, it is, that it does not bring distinctly into view those general powers or forces, namely, attraction, heat, light and electricity, by the agency of one or the other of which all chemical phenomena are controlled. The modes in which these ultimate powers act, constitute the first principles of the science, or its laws; and the greater part of the reasonings of the chemist, consists in tracing individual phenomena to the operation of one or the other of these laws. Thus he accounts for the melting of snow, by ascribing it to heat, because it is one of the known properties or laws of

* See Ure's Dictionary.

heat, to convert solids into fluids. Here he is forced to stop, and can assign no reason *why* heat produces this effect. Some, however, not considering that they have done enough, and all they can do, when they have traced a phenomenon to one of the foregoing ultimate agents, and shown that it is analogous to other well known effects of that agent, attempt a farther explanation by saying, that heat melts snow because it separates its particles so far asunder as to allow of that freedom of motion, which is essential to fluidity. But I can see nothing satisfactory in explanations of this kind. Fluidity is something more than a mere separation of the particles of matter. For, in the first place, such a separation of the particles does not uniformly accompany liquefaction. Water is denser than ice. In the second place, were liquefaction always attended with a diminution of density, we should even then be unable to trace any connexion between this circumstance and the properties of a fluid. There are bodies much rarer than water, as cork, which are still solid.

In the same manner, the only account we can properly give of the phenomena of combination and decomposition, is to point out their conformity with the laws of attraction; which laws are nothing more than the modes in which this ultimate agent has been found, by experiment, to operate. If the chemist supposes that his explanations of individual cases of combination or decomposition amount to any thing more than this, he will find himself mistaken. It is a law of attraction, that is, it is a general fact, ascertained by experiment, that *bodies have different degrees of affinity for each other.* This principle is deduced from the fact, that in some cases the elements of a compound are so strongly united that they can scarcely be separated by any means in our power; while, in other cases, the union is so slight that it is easily overcome, or the elements even separate spontaneously. Hence, in an individual case of decomposition, as when camphor is precipitated from its solution in alcohol, by adding water, the phenomenon is accounted for by saying, that the water takes away the alcohol from the camphor, *because* it has a stronger attraction for it than the camphor has. In this account, if it be considered as a full explanation of the phenomenon, there is something very much of the nature of reasoning in a circle. The only proof we have that water has a stronger attraction for alcohol than camphor has, is the fact that it takes it from water. The fact is therefore ad-

duced to account for itself; and we say that water has a stronger affinity for alcohol than camphor has, because it separates alcohol from camphor, and that it separates alcohol from camphor because it has a stronger affinity for it. In such an explanation of this phenomenon, therefore, we ought to imply nothing more than this, that here is an instance of the operation of that general law of attraction, that *bodies have different degrees of affinity for each other.* A lump of chalk refuses to dissolve in water; one says, it is owing to a want of affinity; another says, its insolubility is the result of cohesion. Both evidently fall short of accounting for the phenomenon; for, in the one case, the want of affinity itself was the thing to be accounted for; and, in the other case, its insolubility remains after its cohesion is destroyed. As the only proof we have of the want of affinity of chalk for water is the fact that it will not enter into combination with it, to ascribe the phenomenon to a want of affinity, is merely to say, that water will not dissolve chalk because it will not dissolve it. Nor is its insolubility merely the result of cohesion; for, overcome its cohesion, as far as possible, by grinding it to powder, it is still insoluble. Then decompose it by muriatic acid, and precipitate it by carbonate of potash; it is now in a state of impalpable powder, and devoid of cohesion;* yet it is as insoluble as before. The fact is, we can assign no adequate reason why muriatic acid should dissolve chalk, and why water should not. All we can do with phenomena of this kind, is to arrange such as are analogous into separate classes.

We may derive a further illustration of the erroneous or defective reasoning complained of, from some of the explanations which are given under the head of caloric. So far as the labors in this department of the science, have been confined to ascertaining the modes in which this ultimate agent operates, in expressing those modes in the form of general laws, and in pointing out the conformity of individual cases to these laws,—so far the way is clear. But when the chemist attempts to assign a reason why heat should produce these effects, that moment he gets beyond his depth. That heat expands all bodies; that it radiates from their surface, and with various degrees of facility from surfaces of different colors

* Cohesion is generally understood to be "that force which unites the integrant particles of a body into one mass." Have we any proof that the integrant particles of the precipitate supposed are united with each other, or is it probable they are?

and textures, but still in degrees which can be accurately compared with one another; that it passes through the substances of different bodies, with various degrees of facility and speed; these are so many general facts, which are learned by experiment, but which no one need attempt to account for. They are severally the modes in which heat operates, and are therefore properly called the laws of heat, and become so many general heads, under which to arrange individual phenomena that result from the agencies of caloric. But as these laws depend on their immediate connexion with the unknown cause of heat, we cannot assign the reason why they are so rather than otherwise. We shall probably never be able to tell why black surfaces radiate better than white, or why silver conducts heat better than platina; but still the accurate investigation of the foregoing general facts, has not terminated in the mere acquisition of so much knowledge, but has enabled us to explain very many phenomena of nature; and probably no facts were ever more useful than these, in their practical applications to the arts. The conversion of sensible into latent heat, during the liquefaction and vaporization of bodies, and its re-appearance in the sensible form, in the opposite processes of congelation and condensation, constitute another class of general facts, ascertained by experiment, which like those before mentioned, are exceedingly important in the explanations they afford of the phenomena both of nature and of art. Some of these, indeed, as the cold produced by freezing mixtures, are facts of the most intricate kind, and such as are farthest removed from common observation; and the luminous explanations of them afforded by the happy discoveries of Dr. Black, furnishes one of the finest examples of the penetration of philosophy into the arcana of nature.

After expressing myself thus respecting these discoveries of Dr. Black, I shall not, I trust, be supposed to betray a wish to undervalue them, when I assert that his explanations of the changes of temperature which result from a change of state in bodies, as from the solid to the fluid, and from this to the aeriform, stop far short of the point at which they are frequently represented to have arrived. For instance, his explanation of freezing mixtures, falls short of assigning an adequate cause of the cold produced. All that Dr. Black in strictness ascertained was, that it is a general fact, that when a body passes from the solid to the fluid state, a portion of heat disappears, and the temperature is reduced; and the

case of a freezing mixture is explained so far only, as it is shown to be an individual example of the foregoing general law.

Some writers, however, have supposed that they were accounting for these changes of temperature, that occur while bodies are changing their state, by referring it to *a change of capacity*. Heat (say they) is absorbed during the liquefaction of ice, because the *capacity* of water for heat is greater than that of ice. But I can see no force in reasoning of this kind. What is enlargement of capacity, but an increased power of absorbing heat? Water, then, during its formation from ice, absorbs heat, because it has an increased power of absorbing heat; and this increase of power itself is is inferred from the fact that it does absorb it. So that the explanation comes to this: *Water absorbs heat, because it absorbs heat.* All we know about the matter is the fact that heat is capable of existing under two different forms, the sensible and the latent; and the knowledge of this fact is of the highest importance, since it enables us to account, most clearly, for almost all the changes of temperature which result from a change of state in bodies, whether to the solid, the fluid, or the aeriform. But even Dr. Black himself seems to have erred in supposing that he had done something more, in investigating the cause of fluidity, than barely to ascertain this fact. He seems to have supposed that he saw the reason why the absorption of a portion of latent heat should maintain a body in the fluid state. But I think we can perceive no connexion between latent heat and fluidity; that is, we can see no reason why a body's happening to contain a portion of heat in the latent state, should keep it fluid. We have before seen that the mere separation of the particles of a solid body, is not sufficient to account for fluidity; and, moreover, if that only were necessary, it is sensible and not latent heat, that causes expansion, and that might therefore be supposed to make some approaches towards the fluid state.

The foregoing examples of loose or defective reasoning, are adduced to show, that something remains to be done to improve the logic of chemistry; nor could we recommend to the young chemist any thing better, than to study the writings of those metaphysical authors, who exhibit the true grounds of physical reasonings. These writers do indeed disagree in some particulars; but the student will, at least, be excited by a perusal of them to think for himself. Among

distinguished chemists, were I called on to name the two who have reasoned in the best manner respecting chemical phenomena, I should say they are Lavoisier and Davy. Both of these great men may have sometimes reasoned erroneously; but still they have displayed consummate skill in deducing correct conclusions from their premises.

I have aimed to show that our reasonings in chemistry, consist in pointing out the accordance of individual phenomena with some one of the established laws of attraction, heat, light or electricity, which powers are therefore denominated the ultimate causes of all chemical phenomena. Indeed, including magnetism, we may pronounce them to be the ultimate causes of all the phenomena of the natural world, whether chemical or mechanical. For, let us take any effect that is produced, in the wide field of inanimate nature, and if we attentively consider the main spring of its action, the primum mobile, we find that it is nothing else than one of these mysterious agents. If I cast my eye on yonder tree, the falling of its leaves, the waving of its boughs, and the colour of its foliage, are effects which can be severally traced to attraction, heat and light. The leaves fall by the force of gravitation; the boughs wave by the action of the wind, which is put in motion by heat, and the colour of the foliage —what is it but a modification of light? The few attempts which have been made to go one step further back, in order to learn what is the nature of these agents themselves, have, for the most part, proved unsuccessful. In chemistry, this inquiry has been chiefly confined to the nature of caloric. All who have laboured at the subject have shown, that it is much easier to refute the arguments of their opponents, than to offer sound ones of their own; and it is very doubtful whether the question respecting the materiality of heat, is capable of being either proved or disproved. It is a high presumption, however, to set bounds to the progress of knowledge. There are some analogies which authorize the belief, that there are material bodies or fluids, still more subtile, than any whose distinct existence has yet been identified. There was a period in the progress of knowledge, when it would have been deemed folly to assert that air itself was material. We have now not only established this fact, but also discovered a series of bodies still more attenuated, descending by regular gradations to hydrogen, which is fourteen times lighter than air. Shall we suppose that nature stops pre-

cisely where our dim perceptions, or our cruder apparatus, come to a stand? Have we left nothing for posterity? From platina to hydrogen, we have descended through a long series of bodies, which have been growing more and more subtile by imperceptible gradations, and it is not agreeable to the analogy of nature to suppose, that the series terminates at so palpable a stage of its progress. In all the departments of Natural History, we see a gradation of objects descending into endless subordination. In the animal creation, for example, man begins with the lion or the elephant, and arrives at length at the insect, that barely discloses its existence when illuminated by the sun beam. Here he makes his stand, and proclaims that the series of animals ends. But a casual discovery presents him with the microscope; and now a still more extended series of animals start into life, and new race after race, still diminishing, pass before him, their numbers swelling as the powers of the instrument are augmented. Hipparchus might vainly have said, "I have counted all the stars." But Herschell saw more in the single narrow field of his great telescope, than all that Hipparchus numbered. Had Herschel been of the same spirit, he might have boasted that he had left nothing unseen amid all the starry train; but lo! as if to mock the presumption of man, four new planets present themselves, which had escaped the gaze of Herschell. All that we can safely infer from these analogies is, that there are fluids in existence, still more attenuated than hydrogen, and that we may take encouragement, that their distinct character will one day be unfolded. Nor, if this should be the case, does any thing seem at present more probable, than that these ultimate agents which are concerned in the production of all chemical phenomena, will be among the number.

There are, however, chemists who are unwilling to acknowledge that we know at present nothing respecting the cause of heat. A few maintain that we have sufficient reason to deny its materiality, while a greater number think that its materiality is capable of being established by proof. The latest attempt that I have seen to establish by argument the doctrine of the materiality of caloric, has been made by Dr. Hare, who has published his views on this subject, in the fourth volume of the American Journal, and also among his Notes to Ure's Chemical Dictionary. His observations are almost exclusively employed in controverting the hypothesis

of Davy, as given in his Elements of Chemical Philosophy. The substance of this hypothesis is, that the phenomena of heat do not depend upon a specific fluid, but are generated by certain motions among the particles of the heated body—those of the hottest body moving with the greatest velocity, and the particles of liquids and elastic fluids having, beside the vibratory motion in common with fluids, an additional motion round their own axes.

"Temperature (says Davy) may be conceived to depend on the velocities of the vibrations; increase of capacity, or the motion being performed in greater space; and the diminution of temperature, during the conversion of solids into fluids and gases, may be explained on the idea of the loss of vibratory motion, in consequence of the revolution of particles round their axes, at the moment when the body becomes liquid or æriform; or from the loss of rapidity of vibration, in consequence of the particles vibrating through greater space." I confess myself utterly unable to make any thing of this doctrine, or to understand how it discloses the least analogy between the properties of motion and the phenomena of heat; and I have long felt surprise, that a chemist so truly great, and so earnest as Sir Humphrey Davy has always been, to place the science of chemistry on its true basis of experiment, should, for a moment, have given way to a hypothesis, which savours more of the days of Alchymy or of Aristotle, than any thing to be met with since the age of Stahl. Dr. Hare, who is equally distinguished for brilliancy of invention and acuteness of reasoning, has attempted to refute this hypothesis by an argument of the nature of a reductio ad absurdum. He has attempted to show, that the supposition that temperature results from the velocity of the particles of heated bodies, subjected to a vibratory motion, is inconsistent with the laws of mechanics. "It is fully established in mechanics (says Dr. Hare) that when a body in motion is blended with and thus made to communicate motion to another body, previously at rest, or moving slower, the velocity of the compound mass, after the impact, will be found, by multiplying the weight of each body, by its respective velocity, and dividing the sum of the products by the aggregate weight of both bodies." He then proceeds to show that the phenomena of temperature do not coincide with this law. Thus, when water and mercury of different temperatures, are added together, the resulting temperature is not a mean, as it would

be were temperature merely the operation of a law of motion, but the water is affected too little, and the mercury too much to admit of our referring the change to such a law. Little as I am disposed to adopt the views of Sir Humphrey Davy, I cannot but think that Dr. Hare has here suggested an answer which is not altogether unobjectionable. The application of his rule, or test, makes it necessary to suppose, that the particles subjected to impact, are all moving in the same direction—that they all actually come into collision, each upon each, and that they are non-elastic; none of which conditions are capable of being proved actually to exist, although it is only when they are all present, that the law of motion which he adduces holds true. Moreover, if Dr. Hare be allowed to have fully and clearly refuted the hypothesis of Sir Humphrey, his argument is still imperfect; for it by no means establishes the doctrine of the materiality of heat, to prove that Davy has failed of showing that it is a product of motion. Both parties, in my view, evince how idle it is to reason respecting chemical phenomena upon mechanical principles.

The foregoing observations may be sufficient to show the state of chemical science, so far as regards the methods of reasoning employed in the explanation of its phenomena. The whole amounts to this, that the fundamental principles of the science consist in the laws of attraction, heat, light and electricity; which laws are the modes in which these several mysterious agents are found, by experiment and observation, to operate; that the true ground of reasoning on chemical phenomena, is to trace every effect to one or the other of these laws, and arrange it under that law in a class with similar facts; that all attempts to investigate the nature of these ultimate agents themselves, have hitherto proved unsuccessful, or even to assign an adequate reason for the effects they produce; and, finally, that a great part of what is erroneous or defective in the prevalent modes of reasoning adopted by chemical authors, results from attempting to explain either the nature of these ultimate causes, or to point out the connexion between them and their effects. I proceed now to offer a concise account of some of the more recent improvements which the science has received, either in the investigation of new principles, or in the discovery of new substances.

(To be continued.)

Art. XVII.—*Particulars of the effects of a stroke of lightning in the house of Madam* Marsh, *widow of the late Rev.* John Marsh, D. D. *in Wethersfield, Connecticut.* Communicated to the Editor, by one of the Ladies of the family.

On Saturday evening, the 3d of June, 1826, while the rain was pouring down powerfully, a clap of thunder burst with a tremendous explosion over the eastern part of the building. The lightning ran down the chimney to the ceiling of the front chamber, where it came through, leaving a hole nearly an inch in diameter; tore off the paper and plaister from the wall, and descended on a row of nails in the laths, to a picture; melted all the gilding, burned and tore one side of the frame, and again rending its way, ran upon the nails to the fire-place; separated the breast work from the chimney, and from thence took a horizontal direction, attracted by an umbrella in the corner of a closet. A small line is to be seen from a nail to a bolt in the opposite closet. From the umbrella, in a triangular turn, it came out over the fire-place in the lower room, in nine holes, the largest the size of a common gimblet; scorching, and slightly tearing the paper. It entered at one corner of a picture, melted the gilding, blackened the frame, and passing off at another corner, separated again into several lines, intersecting each other, until they centred in a nail in the shelf. It passed down back of the moulding, tore away a hard cement below, threw forward a false back of brick and iron, split the floor each side of the hearth, rent off splinters two feet in length, from the under floor in the cellar, and went east and west through a stone wall into the earth.

The greatest force was in the chamber closet. The point of the umbrella was brass, and just beneath the wire which connects the whalebone, it was burnt off, and the silk, the stick, and the whalebone, were nearly consumed. Several folds in some woollen carpets were burnt, leaving not a vestige for a yard in a place; and a fur muff, a cloth coat, and some other articles, were considerably injured. A sleeve and part of the waist of the coat were destroyed, while the cotton lining, to which they were stitched, was left whole, and, excepting a small piece, was not even tender from scorching.

A black sulphurous smoke arose from the spot, and filled the house.

Mrs. Marsh was in the closet, with the door shut, and but a foot distant from the course of the lightning. The sound was dreadful, like cannon at her ears, and the heat inexpressibly great, as if she was in the midst of flames; she spoke at first of intense light, but all consciousness of that has since passed from her mind. In this terrific and awful situation, she was preserved unhurt, came out immediately, closed the door, and went down stairs, expecting to find her family dead. They were in the western part of the house, and received no harm. Mrs. Marsh was clothed in cotton, and a roll of carpeting stood between her and the umbrella. Fire-boards were thrown down, and four rooms filled with the smell of sulphur and covered with soot.

The electrical fluid entered four closets adjoining the chimney in the lower story; ran around china cups, plates, &c. raised and dissolved the gilding, and leaving a dark blueish path, next to a nail, where it splintered the partition, and escaped through the back of the door to a hinge. In a closet, without paint, it discoloured the wood three inches in width, broke four dishes, and drove out nine nails, four of them from a hinge. In a third, it left an aperture as large as a bullet hole in the ceiling, split the floor three feet, and tore up four inches about an inch wide. In a fourth, it overturned, tossed out, and broke large vials of medicines, pill boxes, wafer boxes, &c. &c. drove four nails partly out of the hinges, and rent off a piece of the casement. On the top shelf, lay several iron articles. It pierced the ceiling in the back room, came down in two branches and completely dissipated four cents* which lay upon a nail in the moulding, marking the surrounding spot with black. In the chamber, eight feet from the chimney, it came out over the corner of a looking-glass in three places, the largest like a gimblet-hole; split the back-board of the glass into three parts, melted the gilding, and went off at an opposite corner, in one large place and nine small ones, through the wall, to a window in the room beneath; splintered the casement, by a nail, into five or six small pieces, and killed a rose-bush, which was tied to a nail, on the outside of the house.

* Foreign readers will observe that the cent is a copper coin, of the weight of about 165 grains.—Ed.

Opposite, and fifteen feet from the chimney, hung a piece of embroidery; three small holes are left in the wall over one corner of it; two-thirds of the top of the frame, which is of mahogany, is split up to a corner, where it appears as if the fluid ran down back of the glass to a basket wrought with gold thread, and blackening it, passed off at another corner, through three small places in the wall, and came out in five points, like nail-marks, in the ceiling, over a looking-glass in the first story; ran all over the gilding, and went off through the wall, by the nails which support the glass.

The paint in the chamber was turned of a very dark colour, with a metallic cast. The paper was red and blue: the red, excepting near the floor, has entirely disappeared. There was no lightning rod upon the house.

Since writing the above, the chimney has been examined; a hole an inch long is found in the garret, four feet from the ceiling of the chamber, where it came through: no crack or any other fracture is to be seen.

REMARKS BY THE EDITOR.

Since receiving this account, we have visited and examined the premises, which were the scene of the event described above. The *rending* effects of the lightning were not more conspicuous than they often are, in similar cases, but the delicate selection made of metallic articles, the manner in which they were affected, and the minuteness of the ramifications of the fluid through the apartments, were very remarkable.— Our artificial imitations of the effects of this tremendous agent of the Almighty, are indeed very humble; still, no person conversant with the usual effects of strong electrical and galvanic discharges from powerful batteries, could fail to be struck with the resemblance. The gilding on the edges and figures of the china, and upon the frames of the pictures, was either dissipated or converted into the purple oxid of gold, and stained the shelves and the wood of the frames in the same manner as gold leaf or wire, deflagrated by electricity or galvanism, colors the contiguous substances. The four cents were so perfectly dissipated, that, except a metallic stain on the lead paint of the shelf, not a trace of them remained; they appear to have *flashed away*, like gun-powder.

But the most remarkable circumstance was the preservation of the life of the venerable lady, who was literally enveloped in an atmosphere of lightning, filling a closet of only a few square yards in area. It seems that she had *gone into her closet*, (which was without a window,) and had "*shut the door*," when the astounding explosion happened. The rolls of carpeting, the umbrella, the great coat, the muff—all were more or less, instantly scorched or consumed at her side, and the place was filled with the most overpowering light, heat and noise; but she came out of this furnace, with only the smell of fire upon her garments—entirely without bodily injury, and with scarcely a mental agitation, except of grateful emotion.*

*This is not the place or occasion for the indulgence of personal feelings, regarding a family and scenes with which, in earlier years, we were in habits of interesting intercourse; but it will not be improper to add, that the danger was repeated a few days after, by another stroke of lightning, which now attached itself to the iron conductor, which had, in the mean time, been affixed, in the usual manner, to that end of the house. The lightning passed down the rod, and left a proof of its power in the hole which it tore in the turf as it entered the ground. The contiguous steeple, only a few hundred feet distant, was also struck at the same time.

ART. XVIII.—*Volcano of Kirauea.*

REMARKS BY THE EDITOR.

In our last number, we gave an account of the volcanic character of the Island of Hawaii, derived principally from the journal of the missionaries, published by Mr. Ellis.

The following article, drawn up by the Rev. CHARLES S. STEWART, late a misssionary at Hawaii, although first published in a newspaper,* in a letter to the Editor, Colonel Stone, is too interesting and important a document to be permitted to perish in an ephemeral register. We therefore transfer it, without hesitation, to the pages of this Journal, with the advantage of some corrections obtained in a personal interview with Mr. Stewart himself, from whom, as well as from Mr. Goodrich, we are promised specimens of the various igneous productions of Kirauea.

* The Commercial Advertiser of New-York.

ISLAND OF OAHU, SANDWICH ISLANDS, }
August 26, 1825. }

July 2d, 1825.—Early on Monday, the 27th of June, we commenced our proposed excursion to the volcano. The party from the Blonde, consisted of Lord Byron, Mr. Ball, 1st Lieutenant, Lieut. Malden, the Surveyor, Mr. Davis, the Surgeon, Rev. Mr. Bloxam the Chaplain, Mr. A. Bloxam, the Mineralogist, Mr. Dampier, the Artist, Mr. White, a son of the Earl of Bantry, and Mr. Powell, Midshipman. Maro, a principal chief of the District of Hido, had been appointed by Kaahumanu (favourite Queen of Tamehameha the 1st,) *Caterer General*, and about 100 natives under his authority carried our luggage, provisions, &c. &c. Sir Joseph Banks, or, as more familiarly styled, "Joe Banks," was also in attendance in his diversified capacity of interpreter, gentleman in waiting to Lord B. &c. &c. The Regent (Kaahumanu,) had left nothing indeed undone to render the trip as comfortable as her authority could make it. Neat temporary houses for refreshment and sleeping had been erected, by her command, at intervals of 12 to 15 miles; and the people of the only inhabited district through which we were to pass, had, the week before, been apprised of the journey of the "British Chief," with strict orders to have an abundance of pigs, fowls, taro, potatoes, &c. &c. in readiness for the supply of his company. When all assembled, we formed quite a numerous body, and from the variety of character and dress, the diversity in the burdens of the natives, bundles, tin-cases, portmanteaus, calabashes, kettles, buckets, pans, baskets, &c. &c. with two hammocks, by way of equipage, slung on long poles, and each borne by four men, made a lively and grotesque appearance, while passing in single file, along the narrow winding path which formed our only road.

For the first four miles, the country was uneven and open, and beautifully sprinkled with single trees, clumps and groves of the bread-fruit, the lauala, (pandanus,) and tutui, or candle-tree. We then came to a wood, four miles in width, the out-skirts of which exhibited some of the richest and most delightful foliage I have ever seen. It was composed principally of lofty and wide-spreading candle-trees, whose whitish leaves and blossoms afforded a strong contrast with the dark green of the various creepers, which hung in luxurious festoons and pendants, from their very tops to the ground, forming thick and deeply shaded bowers round their trunks,

The interior, however, was far less interesting, presenting nothing but an almost impenetrable thicket on both sides of the path. This was excessively rough and fatiguing, consisting entirely of loose and pointed fragments of lava, which, from their irregularity and sharpness, not only tore and cut our shoes, but constantly endangered our feet and ankles also. The high brake, ginger, &c. which border and overhang the path, were filled with the rain of the night, and from their wetness, added greatly to the unpleasantness of the walk. An hour and a half, however, saw us safely through, and refreshing ourselves in the charming groves with which the wood was here again edged.

The remaining distance, of near 30 miles, was very much of one character. The path consisted solely of a bed of black lava, so smooth, in many places, as to endanger falling, and still shewing the configuration of the molten stream, as it had rolled down the gradual descent of the mountain, led midway through a strip of open, uncultivated country, from three to five miles wide, skirted on both sides by a ragged and stinted wood, and covered with grass, fern and low shrubs, principally a species of the whortle berry. There were no houses near the path, but the thatch of a cottage, or the rising smoke, seen occasionally, in the edge of the woods, shewed that it was not an uninhabited region. Far on the right and west, the mountains Mouna Kea and Mouna Roa were distinctly visible, and on the left and east, at an equal distance, the ocean with its horizon, from the height at which we viewed it, mingling with the sky.

We dined thirteen miles from the bay, in the shade of a large candle-tree, where a party of people from the neighbouring settlements, were waiting to see the "arii nui mai Berekania mai," (the great chief from Britain,) as they called Lord B. About two miles further, we came to the houses erected for our lodgings the first night: thinking it however, too early to lay by for the rest of the day, after witnessing a dance performed by a company from the surrounding districts, we hastened on, intending to sleep at the next houses, ten miles distant. But night overtook us before we reached them, and perceiving the ruins of two huts, a few rods from our path, we turned aside to them just as darkness began to set in. The sticks forming their frames, were all that remained, but the islanders soon covered them with leaves, and

spread the ground with fresh fern, before laying the mats which were to be our beds.

Our arrival and encampment produced a picturesque and lively scene. The natives, who are not fond of such forced marches as we had made during the day, were more anxious for repose than ourselves, and as soon as they heard of the determination to stop, proceeded with great animation and alacrity to make the necessary preparations for the night. Some ran for leaves and grass for the huts, some for wood for a fire—some for water for our tea, &c. &c. till, in a few minutes, every thing was in as much readiness as if we had expected at an earlier hour to remain there. The darkness, as it gathered round us, rendered more gloomy by a heavily clouded sky, made the novelty of our situation still more striking. Behind the huts, in the distance, an uplifted torch of the blazing tutui nut, here and there indistinctly revealed the figures and costume of many of our attendants, spreading their couches under the bushes, or in the open air. A large lamp suspended from the centre of our rude lodge, which was entirely open in front, presented us, in *bolder relief*, seated *a la Turque* round Lord Byron, who poured out "the cup that cheers but not inebriates;" the more curious of our dusky companions, both male and female, in the mean time, pressing in numbers about our circle, as if anxious "*to catch the manners living as they rose.*" A large fire of brushwood exhibited the objects of the fore-ground, in still stronger *lights* and *shadows*. Groups of both sexes and all ages were seated or standing round, wrapped up, from the chilliness of the mountain air, in their large mantles of white, black, green, yellow and red—some smoking their evening pipe, some throwing into the embers, and others scratching from them, a fish or potatoe, or other article of food—some giving a loud halloo, in answer to the call of a straggler just arriving—others wholly taken up with the proceedings of the sailors cooking our supper, and all chattering on a hundred different subjects, with the volubility of so many magpies.

By daylight the next morning, we were on the road again. At 9 o'clock we breakfasted at the last houses put up for our accommodation on the way, and by 11, had arrived within three miles of the object of our curiosity. For the last hour, the scenery had become more interesting than it had been during most of the preceding day; our path was occasion-

ally skirted with groves and clusters of trees, and fringed with a greater variety of vegetation. Here, also, the smoke of the volcano was just descried, settling in light fleecy clouds to the south-west. Our resting place, at this time, was a delightful spot, commanding a full view of the wide extent of country over which we had travelled, and around it, the ocean, which, from the vast and almost undistinguished extent of its horizon, seemed literally an "illimitable sea." The smooth green sward, under a majestic koa tree, (an acacia,) nearly encircled by thickets of a younger growth, afforded a refreshing couch on which to take our luncheon. We tarried, however, but for a moment, and then hurried on to the grand object before us.

The nearer we approached, the more heavy the column of smoke appeared, and excited, to intenseness, our curiosity to behold its origin. Under the influence of this excitement, we hastened forward with rapid step, regardless of the heat of a noonday sun, and the fatigue of a walk of thirty-six miles already accomplished. A few minutes before 12 o'clock, we came suddenly on the brink of a precipice 150 or 200 feet high, covered with shrubbery and trees. Descending this, by a path nearly perpendicular, we crossed a plain, half a mile in width, enclosed, except in the direction we were going, by the cliff behind us, and found ourselves, a second time, on the top of a precipice 400 feet high, also covered with bushes and trees. This, like the former, swept off to the right and left, enclosing, in a semi-circular form, a level space, about a quarter of a mile broad, immediately beyond which, lay the tremendous abyss of our search, emitting volumes of vapour and smoke, and laboring and groaning, as if in irrepressible agony, from the raging of the conflicting elements, within its bosom. We stood but a moment, to take this first distant gaze, then hastily descended the almost perpendicular height, and crossed the plain to the very brink of the crater.

There are scenes to which description, and even painting, can do no justice, and in conveying any adequate impression of which, they must ever fail. Of such, an elegant traveller rightly says, "the height, the depth, the length, the breadth, the combined aspect may all be correctly given, but the mind of the reader will remain untouched by the emotions of admiration and sublimity which the eye witness experiences." That which here burst on our sight, was, emphatically, of

this kind, and to behold it without singular and deep emotion, demands a familiarity with the more terrible phenomena of nature, which few have the opportunity of acquiring. Standing at an elevation of 1500 feet, we looked into a horrid gulf, not less than eight miles in circumference, so directly beneath us, that in appearance we might, by a single leap, have plunged into its lowest depth. The hideous immensity itself, independent of the many frightful images embraced in it, almost caused an involuntary closing of the eyes against it. But when to the sight, is added the appalling effect of the various unnatural and fearful noises, the muttering and sighing, the groaning and blowing, the every agonized struggling of the mighty action within—as a whole, it is too horrible!—And, on the first moment, I felt like one of my friends, who, on reaching the brink, recoiled and covered his face, exclaiming, "call it weakness, or what you please, but I cannot look again!"

It was sufficient employment for the afternoon simply to sit and gaze on the scene, and though some of our party strolled about on the level above, and one or two descended a short distance in the crater, the most of our number deferred all investigation till the next morning.

From what I have already said, you will perceive, that this volcano differs, in one respect, from most others of which we have accounts: the crater, instead of being the truncated top of a mountain, distinguishable at a distance in every direction, is an immense chasm, in an upland country, near the base of the mountain Mouna Roa,* approached, not by ascending a cone, but by descending two vast terraces, and not visible from any point, at a greater distance than half a mile: a circumstance, which, no doubt, from the suddenness of the arrival at it, adds much to the effect of a first look from its brink. It is probable, that, originally, it was a cone—but assumed its present aspect, it may be centuries ago, from the falling in of the whole summit. Of this the precipices we descended, which entirely encircle the crater in circumferences of 15 and 20 miles, give strong evidence: they having unquestionably been formed by the sinking of the mountain, whose foundations had been undermined by the devouring

* The height of Mouna Roa has never been accurately measured, but variously estimated from sixteen to eighteen thousand feet, being thus one or two thousand feet higher than Mont Blanc, and five or six thousand feet higher than the Peak of Teneriffe.

flames beneath. One half of the present depth of the crater has been caused, in the same manner, at no very remote period. About midway from the top, a ledge of lava, in some places many rods, and in others only a few feet wide, extends entirely round, (at least so far as an examination has been made) forming a kind of gallery, to which you can descend in two or three places, and walk as far as the smoke, settling at the south end, will permit. This offset leaves incontestible marks of having once been the level of the fiery flood, boiling in the bottom of the crater; a subduction of lava, by some subterranean channel, has since taken place, and sunk the abyss many hundred feet, to its present depth.

The gulf below contains between fifty and sixty smaller conical craters, many of which are in constant action. The tops and sides of two or three of these are covered with sulphur of mingled shades of green and yellow; with the exception of these, the ledge, and every thing below it, is of a dismal black. The cliffs above the ledge, forming the outer edge of the crater, are on the northern and western sides perfectly perpendicular, and of a red color, every where exhibiting the marks of former powerful ignition. Those on the eastern side are less precipitous, and consist of entire banks of sulphur, of a delicate and beautiful yellow. The south end is wholly obscured by the smoke, which fills that part of the crater and spreads widely over the surrounding horizon.

As the darkness of the night gathered round us, new and powerful effect was given to the scene. Fire after fire, which the glare of mid-day had entirely concealed, began to glimmer on the eye, with the first shades of the evening; and, as the darkness increased, appeared in such rapid succession, as forcibly to remind me of the hasty lighting of the lamps of a city on the sudden approach of a gloomy night. Two or three of the small craters, nearest to the north side, where we lodged, were in full action, every moment casting out stones, ashes and lava, with heavy detonations, while the irritated flames accompanying them glared widely over the surrounding obscurity, against the sides of the ledge and upper cliffs, richly illuminating the volumes of smoke at the south end, and occasionally casting a bright reflection on the bosom of a passing cloud. The great seat of action, however, seemed to be at the southern and western end, where an exhibition of ever-varying fire-works was presented, surpassing in beauty and sublimity, all that the ingenuity of art ever de-

vised. Rivers of fire were seen rolling in splendid coruscation among the laboring craters; and, on one side, a whole lake, whose surface constantly flashed and sparkled with the agitation of contending currents.

Expressions of admiration and astonishment burst momentarily from our lips, and though greatly fatigued with our walk, it was near midnight before we could yield ourselves to a sleep, often interrupted during the night, to gaze on the light with renewed wonder and surprise. As I laid myself down on my mat, fancying the very ground, which was my pillow, to shake beneath my head, the silent musings of my own mind were, "Great and marvellous are thy works, Lord God Almighty!—greatly art thou to be feared, thou King of saints."

On Wednesday, the 29th, after an early breakfast, our party, excepting Lieut. Malden, who was ill, Mr. Dampier, who remained to take a sketch, and Mr. Ruggles, who chose to satisfy his curiosity above, prepared for a descent into the crater. One of the few places where this is practicable, was within a rod of our hut. For the first 400 feet, the path was steep, and from the looseness of the stones and rocks in and about it, required caution in every movement. A slight touch was sufficient to detach them and send them bounding downwards, with great velocity, to the imminent danger of all in their way. The remaining distance to the ledge, of about the same number of feet, was gradual and safe, the path having turned into the bed of an old channel of land, which ran off in an inclined plane, till it met the offset, before described, more than a quarter of a mile west of the place where we began the descent. By the time we had all reached this spot, the natives acting as guides with the Messrs. Bloxam and Mr. Powel, had preceded the rest of our number too far to be overtaken, and we became two parties for the rest of the morning; the last, into which I fell, consisting of Lord B., Mr. Ball, Mr. Davis, and Mr. White, with Lord B's servant and my native boy, to carry a canteen of water and the specimens we might collect. Before descending, we had provided ourselves with long canes and poles, by which we might test the soundness of any spot before stepping on it, and immediately on reaching the ledge, found the wisdom of the precaution.

This offset is formed wholly of scoria and lava, mostly burned to a cinder, and is every where intersected by deep

crevices and chasms, from many of which, light, vapor and smoke, and from others, a scalding steam, are emitted. The general surface is a black glossy incrustation, retaining perfectly the innumerably diversified tortuous configurations of the lava, as it originally cooled, and so brittle as to crack and break under us, like ice, while the hollow reverberations of our footsteps beneath, sufficiently assured us of the unsubstantial character of the whole mass. In some places, by thrusting our sticks down with force, large pieces would give way, disclosing fissures and holes apparently without bottom. These, however, were generally too small to appear dangerous. The width of this ledge is constantly diminished, in a greater or less degree, by the falling of large masses from its edges into the crater; and it is not impossible that in some future convulsion of the mountain, the whole structure may yet be plunged into the abyss below.

Leaving the sulphur banks, on the eastern side, behind us. we directed our course under the northern to the western cliffs. As we advanced, these became more and more perpendicular, till they presented nothing but the bare and upright face of an immense wall, from eight to ten hundred feet high, on whose surface huge stones and rocks hung, apparently so loosely as to threaten falling at the agitation of a breath. In many places, a white curling vapour issued from the sides and summit of this precipice, and in two or three others, streams of clay-coloured lava, extending almost from the top to the bottom, had cooled in the form of small cascades, evidently at a very recent period. At every step something new attracted our attention, and by stopping sometimes to look up, not without a feeling of apprehension, at the enormous masses over our heads—at others, to gain, by a cautious approach to the brink of the gulf, a nearer glance at the equally fearful depth below—at one time, turning aside to ascertain the heat of a column of steam, and at another, to secure some unique or beautiful specimen, we occupied more than two hours, in proceeding the same number of miles.

We then came to a spot, on the western side, where the ledge widened many hundred feet, and terminated on the side next the crater, not as in most other places, perpendicularly, but in a vast heap of broken cakes and blocks of lava, loosely piled together as they had been shattered from above in the quakings of the mountain, and jutting off to the bot-

tom in a frightful mass of ruin. Here we had been informed, the descent into the depth of the crater could be most easily made, but without a guide, were at a loss what course to take, till we unexpectedly descried the gentlemen who had preceded us, re-ascending. They dissuaded us most strenuously from proceeding further, but their lively representations of the difficulty and dangers of the way, only strengthened the resolution of Lord B. to go down; and knowing that the crater had been crossed at this end, we hastened on, notwithstanding the refusal of the guide to return with us. The descent was as perilous as it had been represented to be, but by proceeding with great caution, testing well the safety of every step before committing our weight to it, and often stopping to select the course which seemed least hazardous, in the space of 20 minutes, we reached the bottom by a zig-zag way, without any accident of greater amount than a few scratches on the hands, from the sharpness of the fragments of lava by which we were occasionally obliged to support ourselves. When about half way down, we were encouraged to persevere, by meeting an Islander, who had descended on the opposite side and made his way over. It was only, however, from the renewed assurance it gave of the practicability of our attempt, for besides being greatly fatigued, he was much cut and bruised from a fall—said the bottom was "ino, ino roa-kawahi o Debelo"—"very, very bad—the place of the Devil." He could be prevailed on to return with us, only by the promise of an ample reward.

It is difficult to say, whether sensations of admiration or of terror predominated, on reaching the depth of this tremendous spot. As I looked up at the gigantic wall, which on every side rose to the very sky around me, I felt oppressed, for a moment, by a sense of confinement to a most unpleasant degree. Either from the influence of imagination, or from the actual effect of the intense power of a vertical sun, added to the heated and sulphurous atmosphere of the volcano itself, I experienced an agitation of spirits, and a difficulty of respiration, that made me cast a look of wishful anxiety to our hut, which at an elevation of 1500 feet, seemed only like a bird's nest on the opposite cliff. These emotions, however, soon passed off, and we began with great spirit and activity the enterprize before us. I can compare the general aspect of the bottom of the crater to nothing, that will give a livelier image of it to your mind, than to the appearance the *Otsego*

would present, if the ice with which it is covered in the winter, were suddenly broken up by a heavy storm, and as suddenly frozen again, while large fragments were still tossing and dashing and heaping against each other, with the motion of the waves. Just so rough and distorted was the black mass under our feet, only an hundred fold more terrific, independent of the innumerable cracks, fissures, deep holes and chasms, from which sulphurous vapour, steam and smoke were exhaled, with a degree of heat that testified to the near vicinity of fire.

We had not proceeded far, before our path was intersected by a chasm at least 30 feet wide, and of a greater depth than we could ascertain, at the nearest distance we dare approach it. The only alternative was to return, or follow its course till it terminated or became narrow enough to be crossed. We chose the latter, but soon met an equally formidable barrier in a current of smoke, so highly impregnated with a suffocating gas, as not to allow of respiration. While hesitating what to do, we perceived this to be swept off, occasionally, by an eddy of the air in a direction opposite to that in which it generally settled, and watching an opportunity when our way was thus made clear, we held our breath and ran as rapidly as the dangerous character of the ground would permit, till we gained a place beyond its ordinary course. We here found ourselves unexpectedly delivered also from the other impediment to our progress—the chasm, which abruptly ran off in a direction far from that we wished to pursue.

We were now at an inconsiderable distance from one of the largest of the conical craters whose laborious action had so greatly impressed our minds during the night, and we hastened to a near examination of it. So prodigious an engine I never expect again to behold. On reaching its base, we judged it to be 150 feet high—a huge, irregularly shapen inverted funnel of lava, covered with clefts and orifices, from which bodies of steam escaped with deafening explosions, while pale flames, ashes, stones, and lava, were propelled, with equal force and noise, from its ragged and yawning mouth. The whole formed so singular and terrific an object, that though my drawing book had been accidentally left with my boy, who was unwilling to descend from the ledge with us, in order to secure a hasty sketch of it, I permitted the other gentlemen to go a few yards nearer than I did, while I occupied

myself with my pencil on a rough piece of blotting paper, brought by one of the party to wrap round the more delicate specimens we might collect. Lord Byron and his servant ascended the cone several feet, but found the heat too great to remain longer than to detach with their sticks, a piece or two of recent lava burning hot.

So highly was our admiration excited by the scene, that we forgot the danger to which we might be exposed should any change take place in the currents of destructive vapours which exist in a greater or less degree in every part of the crater, till Mr. Davis, after two or three ineffectual intimations of the propriety of an immediate departure, warned us, in a most decided tone, not only as a private friend, but as a professional gentleman, of the peril of our situation—assuring us that the inspirations of the air by which we might be surrounded, would prove fatal to every one of us. We felt the truth of the assertion, and notwithstanding the desire we had of visiting a similar cone covered with a beautiful incrustration of sulphur, at the distance of a few hundred yards only from where we then were, we hastily took the speediest course from so dangerous a spot. The ascent to the ledge was not less difficult than the descent had been, and for the last few yards was almost perpendicular; but we all succeeded in gaining its top in safety, not far from the path where we had in the morning descended the upper cliff.

We reached the hut about 2 o'clock, nearly exhausted with fatigue, thirst and hunger, and had immediate reason to congratulate ourselves on a most narrow escape from suffering and extreme danger, if not from death. On turning round, we perceived the whole chasm to be filling with thick sulphurous smoke, and within half an hour, it was so completely choked with it that not an object below us was visible. Even in the unconfined region above, the air became so oppressive as to make us think seriously of a precipitate retreat. This continued to be the case for the greater part of the afternoon. A dead calm took place both within and without the crater; and from the diminution of noise, and the various signs of action, the volcano itself seemed to be resting from its labors.

Towards evening the smoke again rolled off to the south, before a fresh breeze, and every thing assumed its ordinary aspect. At this time Lieut. Malden, notwithstanding his indisposition, succeeded in getting sufficient data to calculate

the height of the upper cliff. He made it 900 feet, agreeing with the measurement of some of the missionaries some months before. If this be correct it is judged that the ledge cannot be less than 600 feet above the bottom, thus making the whole depth of the crater, that which I have stated it in the preceding pages to be, 1500 feet. On similar grounds its circumference at the bottom has been estimated at a distance of from 5 to 7 miles, and at its top from 8 to 10.

Greatly to our regret, we found it would be necessary to set off on our return early the next morning, all the provisions for the natives being entirely expended. We could have passed a week here with undiminished interest, and wished to remain at least one day longer, to visit the sulphur banks on the eastern side, which abound with beautiful crystalizations, and to make some researches on the summit. We would have been glad also, to have added to the variety of specimens we had already collected, especially of the volcanic sponge, and capillary volcanic glass, not found on the side of the crater where we encamped. But it was impossible, and we made preparations for an early departure.

The splendid illuminations of the preceding evening were again lighted up with the closing of the day, and after enjoying their beauty for two or three hours, with renewed delight, we sought a repose which the fatigue of the morning had rendered highly desirable. The chattering of the islanders around our cabin, and the occasional sound of voices in protracted conversation among our own numbers, had, however, hardly ceased long enough to admit of sound sleep, when the volcano again began roaring and labouring with redoubled activity The confusion of noises was prodigiously great. In addition to all we had before heard, there was an angry muttering and rumbling from the very bowels of the abyss, accompanied, at intervals, by what appeared the desperate efforts of some gigantic power struggling for deliverance. These sounds were not fixed or confined to one place, but rolled from one end of the crater to the other; sometimes seeming to be immediately under us, when a sensible tremor of the ground on which we lay took place, and then again rushing to the farthest other extremity with incalculable velocity. The whole air was filled with the tumult, and even those most soundly asleep, were quickly roused by it to thorough wakefulness. Every monition momentarily increased, and Lord B. springing up in his cot, exclaimed, "We shall certainly

have an eruption—such power must burst through every thing." He had scarcely ceased speaking, when a dense column of black smoke, was seen rising from the crater, directly in front of us—the subterranean struggle at the same time ceased, and immediately after, flames burst from a large cone, near which we had been in the morning, and which then appeared to have been long inactive. Red-hot stones, cinders, and ashes were also propelled, with immense violence, to a great height, and shortly after, the molten lava boiled over and flowed down the sides of the cone, and on the surrounding scoria, in two beautiful curved streams, glittering with indescribable brilliancy.

A whole lake of fire also opened in a more distant part. This could not have been less than two miles in circumference, and its action was more horribly sublime than any thing I ever imagined to exist, even in the idler visions of unearthly things. Its surface had all the agitation of an ocean—billow after billow, tossed its monstrous bosom in the air, and, occasionally, those from opposite directions met, with such violence, as to dash the fiery spray, in the concussion, forty or fifty feet high. It was at once the most splendidly beautiful, and dreadfully fearful of spectacles, and irresistibly hurried the thoughts to that lake of fire from whence the smoke of torment ascendeth for ever and ever! No work of Him who laid the foundations of the earth, ever brought to my mind the awful revelations of his word with such overwhelming impression: Truly "*with God is terrible majesty*"—"let all the nations say unto God, *How terrible art thou in thy works!*"

Under the name of *Pele*, (pay-lay,) this volcano, as you may have seen stated in the Missionary Herald, was one of the most distinguished and most feared of the gods of Hawaii.* Its terrific features are well suited to the character and abode of an unpropitious demon, and few works in nature would be more likely to impose thoughts of terror on the ignorant and superstitious, or from their destructive rava-

* *Pele*, is the all powerful goddess of volcanoes, with the natives, and Kuauea is the habitation of herself and her ministering deities. The conical craters are considered their houses, where they frequently amuse themselves by playing at *koriane;* the roaring of the furnaces, and the crackling of the flames, are the *kani* of the *hura*, the music of their dance; and the red flaming surge is the surf wherein they play sportively on the rolling wave. A spirited account of a singular meeting between Mr. Ellis and his party with Oani, the priestess of Pele, is given in the North American.

ges sooner lead to sacrifices of propitiation and peace. It is now rapidly losing its power over the minds of the people. Not one of the large number in our company seemed to be at all apprehensive of it as a supernatural being.

After an almost sleepless night, we early turned our faces homeward, not without many a "lingering look behind," even from the very entrance of our path. It was precisely 6 o'clock, when the last of our party left the brink. Never was there a more delightful morning. The atmosphere was perfectly clear, and the air, with the thermometer at 56° Farenheit, pure and bracing. A splendid assemblage of strong and beautifully contrasted colors glowed around us. The bed of the crater, still covered with the broad shadows of the eastern banks, was of jetty blackness. The reflection of the early sun added a deeper redness to the western cliffs—the bright yellow of those opposite showed here and there a tinge of vermillion, while the body of smoke, rising between them, hung in light drapery of pearly whiteness against the deep azure of the southern sky. Mouna Roa and Mouna Kea, in full view in the west and north, were richly clothed in purple, while the long line of intervening forests, the level over which we were passing, and the precipice by which it was encircled, thickly covered with trees and shrubbery, exhibited an equally bright and lively green.

On gaining the top of the first precipice, the distant view of the crater and the surrounding scenery was so strikingly beautiful, that, though most of the gentlemen had preceded me, I stopped long enough to secure the outlines of a drawing. We walked rapidly during the morning, and by 12 o'clock reached the houses built for our accommodation half way between the harbour and volcano. We determined to spend the night at this place. After dinner, a native dance was performed, similar to that witnessed on our way up the mountain on Monday—after which we retired early to rest—set off before day-light the next morning, and reached the Bay in safety, at 1 o'clock on Friday.

INTELLIGENCE AND MISCELLANIES.

1. *Notice of Dr. Webster's Text Book.*—A Manual of Chemistry, on the basis of Prof. Brande's; containing the principal facts of the Science, arranged in the order in which they are discussed and illustrated in the Lectures at Harvard College. Compiled from the works of Brande, Henry, Berzelius, Thomson, and others. Designed as a text book for the use of students, and persons attending Lectures on Chemistry. By JOHN W. WEBSTER, M. D., Lecturer on Chemistry in Harvard University. Boston: Richardson & Lord. 1 vol. 8vo. pp. 603.

The increased attention which is given to the study of chemistry in this country, cannot but afford the highest gratification to those who pursue it as a profession, and not less to all who are desirous of seeing our country elevated, and improved by the genial influence of the physical sciences. We have hardly a college or an academy in which chemistry is not now made an important branch of education, and the study of elementary works is prosecuted to greater or less extent, in many of our schools. The sciences of chemistry and mineralogy are now taught at Harvard University by Dr, Webster, the author of the work, the title of which we have given above, who is connected with the college as resident lecturer. The present volume is the first fruits of his labours, and is a pleasing proof of his industry and zeal in the duties of his station.

A work like this was certainly much wanted. Many smaller works, designed chiefly as school books, have been published within a year or two; but none that is sufficiently extended for more advanced students. An edition of Prof. Brande's work was published a few years ago, with additions by Dr. McNeven, of New-York; and Henry's most excellent work has gone through several editions. It was, at first, a work in one volume, of moderate size; and after it became two volumes, it was republished in this country, in three successive editions, *with notes* by the Editor of this Journal, and afterwards by Dr. Coxe and Dr. Hare, in Philadelphia. It has become, in England, a large work, in two volumes, of

about 700 pages each; and the additions to the last edition but one having been reprinted in this country, the last American edition, published in Philadelphia, is in three volumes. Dr. Henry's work has been very generally studied, and is used as a text book in some of our literary institutions; but it is now more properly to be considered *a system* of chemistry, than an elementary work, and takes its place by the side of the still more voluminous works of Thomson and Murray. It is an expensive work, and contains much which, although it is extremely valuable to the professed chemist, is yet unnecessary to the beginner. A work was obviously wanted, which should contain all the elements of the science, and be less extensive than Henry, but more so than Brande, who is much too concise; and such a work is this of Dr. Webster.

A detailed knowledge of chemistry cannot be attained by every one. The science is more grand and extensive in its outline, than is generally supposed. The extent of its objects is apt to be overlooked in the attention to its manipulations and minuter details. It has rapidly grown up into an extensive accumulation of facts, to which additions are making almost daily from almost all parts of the globe. It requires such an appropriation of time and property, such a variety of expensive and delicate instruments, such an acquisition of manual dexterity, and so much thought and attention, for its successful prosecution, as must confine its full pursuit to a few professors and enthusiastic amateurs. But a general knowledge of its outlines may be obtained by any one. Where the least desire of knowledge prevails, the time spent upon this branch of science is amply rewarded. Nor is it difficult for those engaged in other pursuits, to obtain a sufficiently detailed knowledge of those parts or branches of chemistry, that may be useful to their particular science, art, or manufacture.

In the advertisement or preface to Dr. Webster's Manual, he has stated the character of the work, that it is a compilation. Every one who has paid attention to the progress of chemistry, and witnessed the rapid multiplication of beautiful discoveries, and the developement of new theoretical views on chemical philosophy, will at once perceive the labor and difficulty which must attend the judicious compilation of a work like this. The number of works to be consulted, the great mass of scientific journals to be explored, the discordant statements to be reconciled, the different results to be com-

pared and examined, present an apalling array to him who undertakes it without a fixed resolution and the most untiring assiduity. That these important requisites have been possessed by the gentleman to whom we are indebted for this volume; and that they have been exercised with candor and impartiality, we find abundant evidence.

The basis of Dr. Webster's Manual is stated to be the work of Prof. Brande. The latter is an exceedingly valuable work, the general arrangement of which is not less convenient than philosophical; but in this respect some improvement has been made in the volume under notice. A very considerable part of Brande's work is occupied with tables of the strength of acids, of equivalent numbers, &c. and a still larger part by the chapters on mineralogy. Dr. Webster has very judiciously omitted these parts, and has retained all the strictly chemical part. He has not, however, simply republished Mr. Brande's text, but has altered it where the progress of chemistry has rendered it necessary, and has extended nearly all the descriptions of the various substances, especially the salts, on which Mr. Brande is much too concise; often giving little more than a catalogue of them.

There is another great deficiency, not only in Mr. Brande's work, but in almost all the chemical books: we allude to the paucity of the experiments. The principles of the science cannot be too fully illustrated by appeal to actual experiment; and it is almost an unnecessary remark, that nothing engages and rivets the attention of students to the subject, so strongly as the evidence addressed to the eye. This defect is not found in Dr. Webster's work. It abounds with experiments, which are in many cases original, and introduced with great judgment. Most of them are of such a nature, and so fully described, together with the necessary apparatus, that any one may perform them by himself. The plates are very numerous, and executed with great neatness. The volume, although containing but 600 pages, comprises as much matter as is usually made to occupy twice the room: the pages are of an unusually large size, and at the same time printed in a neat and fair type.

We trust that Dr. Webster will pursue the plan he has proposed in his preface, of publishing a volume to accompany the present one, to contain the various chemical tables and modes of analysis. This will be very convenient in the laboratory, and as a book of reference.*

* We understand that this work has been adopted as a text book, at Cambridge and Amherst Colleges, and at the U. S. Military Academy, West-Point.

2. *Linnæan Society of Paris.*—With pleasure we observe that, intent on the progress and improvement of the natural sciences, the parent institution of Paris has presented to the Linnæan Branch of New-York a handsome bust of Linnæus; also, that they annually dispose of a complete set of their printed annals, to be presented to foreign societies composed of their own members, or to others directing their labors and studies to the same objects. This noble and liberal plan creates in every section of the civilized world, channels for collecting and diffusing the knowledge of the works and discoveries of the whole. In conformity to these principles, Dr. Felix Pascalis, president of the New-York Linnæan Branch, and an honorary member of the New-York Horticultural Society, has obtained a kindred and useful intercourse between the two institutions, in consequence of which, the inauguration in New-York of the first bust from the marble statue of the University of Upsal, was made at the anniversary of the Horticultural Society. Dr. Samuel L. Mitchill, honorary president of the Linnæan Branch, and the orator of the day, delivered a very interesting and learned address, before a respectable assembly of horticulturalists of New-York, and a numerous concourse of citizens and ladies. A sumptuous dinner was also prepared, in a large hall, ornamented with garlands of greens and shrubs, and a great quantity of fruits of the best quality, choice and rarity, for the exhibition and distribution of premiums, in presence of a large company of gentlemen and ladies, who were at liberty to taste fruit or to pick up flowers. Under an elegant triumphul arch, and on a columnar pedestal, was placed the bust of Linnæus, with a crown composed of specimens of the twenty-four classes of the vegetable kingdom, in the most correct choice of flowers and plants, all indicative or emblematic of the dominion of the great patriarch of the natural sciences. This work of Mons. Parmentier, horticulturist of New-York, offered no less than an extensive assemblage of ninety species, all in a state of flowery or blooming luxuriance.

After the dinner, and in answer to a toast, or sentiment, addressed to him as President of the Linnæan Branch, and an honorary member of the horticultural society, Dr. Pascalis delivered a short addresss, from which we extract his account of the last years Linnæan labours, in relation to agriculture, horticulture, and botany:

"The process of abstracting electricity from the clouds, by planting poles covered with twisted straw, as mentioned last year, and thereby guarding cultivated fields against the destructive effects of hail-storms, has been fully and successfully exemplified in extensive districts of Germany and Italy, in or about the lower Alps and Appenines; and it is now still further ascertained, that not only metallic, but ligneous or vegetable points, can divert torrents of electricity in different currents; also, that this element is as necessary to plants as pure air or other gases, because, by their sharp pointed leaves and thorns, they abstract it from the atmosphere. This subject, which so strikingly evinces the wisdom of the Creator, was experimentally demonstrated by a Linnæan member, who has subjected electricity to positive and negative evolutions, by means of thorny shrubs, and as easily as Franklin drew it from the clouds with a child's plaything, a flying kite, armed with a metallic point!

"Another prodigious secret has also been revealed to us. It is that of ascertaining which is the best period for early or late sowing, during autumn, or in October. A mistake in this respect, should a soil be clayish, or otherwise subject to late droughts, may prove ruinous; and since it is not given to human wisdom to foresee how and when hygrometic vicissitudes may take place, it has been ingeniously devised to procure comparative tables of the rainy days in the course of years, and as many as fifty—then of the rainy days of each year, as far as the last of September; and by the proportion of the mean anterior periods, to judge of the next approaching October completion, on a certainty of forty-six against one! These tables, Mr. President, I will be happy to furnish the Horticultural Society with.

"In relation to *horticulture*, the London and Paris members have concurred in the same method and principles of defining what kind of climate each precious plant requires. Messrs. T. Frederick Daniel, and Soulange-Bodin, affirm that such a climate consists in temperature, moisture, electricity, light, and irradiation of plants; besides the required quality of the soil. The views of the French horticulturist, on the spontaneous exsiccation of the plants, and on their relative location, under which the requisite conditions of climate are to be artificially procured or modified, are particularly novel and interesting.

"Sir Humphrey Davy, and Mons. de Paupaile, a Paris Linnæan member, invite to their chemical laboratory, all horticulturists who are to be the best judges of their vegetable earths, whether lime, clay, alumine, or magnesia, predominate in them; having besides some inflammable or oxygenated metallic bases, besides vegetable and animal matters. That these elements, with a great deposition from other earths and carbon, &c. are the principal support of plants, is evident by the gramineous kind, which contain so much siliceous earth, whilst their nutritive and circulating fluids, if analyzed, are found to be binary, or such other compounds as always constitute organic animal or vegetable matter. The horticulturist should, therefore, be provided with his chemical laboratory, with acids, alkaline, and other compound tests, to make up, judge, and correct his composts, as the occasion will require.

"The study of botany, so necessary to horticulturists, is next directed by our Linnæan friend, (Mons. Victor Auger,) in a much easier method than that which is wrongly thought to be indispensably required for it, to wit: to be familiar with various systems of that science in Greek and Latin vocabularies; to collect quantities of plants; to dry them up in large herbaria; to purchase extensive libraries and floràs; and to be possessed, in fine, with all that appertain to transcendent botany. With such means, the transcendent botanist knows, after all, much less of the plants than a simple horticulturist, in the very ground which he treads upon, because his memory is overloaded with distant, unconnected, and superfluous materials, instead of which, he should have applied himself to the knowledge of indigenous plants, before the exotic; content himself to designate them with vernacular and practical names; to class them in a natural, in preference to an artificial method; by their flower, or by their use; by their size, or by their duration; by their habits, or by their localities; even by their popular attributes; for it is a fact, that in any existing language, the ordinary name of a plant is most significative of any of the above characters or attributes. The ancients had not a better method to study botany since the days of Theophrastus, to the age of Tournefort, Linnæus and Jussieu. I have no doubt but the celebrated Bernardin de St. Pierre could have introduced a fourth system of nomenclature in botany—that of classing plants by the roots, which in general present a

great variety of substance and forms, had he not found in time, that it was absurd to be obliged to pull up a plant from the ground, before he could class it! Still, Bernardin de St. Pierre was a great botanist. This fact shows that there is no natural method that can oppose the progress of study in botany, while the artificial systems frequently obstruct or retard the acquaintance with individuals.

"When that amiable and fascinating science has thus been studied, and with the help only of distinct designation or structure of parts, the knowledge of *exotics* can be introduced and added to the acquired stock. These are like strangers, who, with their names, titles and decorations, are hospitably received by the horticulturist, to whom attention will be paid, and also to their scientific and systematic appendages, whether of the Linnæan or of Jussieu's denomination. There will be no difficulty for him to dispose of this great accession of individuals, in one way or another, because his mind is now already accustomed to methodize and arrange families of plants, by their most striking and similar features, subjecting, however, the whole of them to his parental discipline, for the preservation of order, and for all the good purposes of his labours and avocations!

"Such is, Mr. President, the respectful homage which, from the last annals, and in the name of the L. S. P. I this day humbly submit to the N. Y. H. Society. I have to add my own thankful acknowledgment for this inauguration of our bust of Linnæus, the first introduced in this city, and the perfect image of the greatest instructor of mankind in botany and horticulture. When Plato opened his academic school in a private garden of Academus, in the vicinity of Athens, he wished that the image of Socrates should be the best ornament of it. Thus you have gloriously admitted the image of Linnæus. The northern regions, where he was born, often create Boreal lights, to the astonishment of the equatorial and southern inhabitants of the world. Exactly like them, this great man and almost divine mind, has enlightened mankind on the only order in which the Almighty Creator of the world has performed all its wonders. *Deus creavit, Linnæus disposuit.* This image, gentlemen, from the statue of marble erected to his memory by his sovereign, who could not possess a greater subject in his realms, is actually crowned by the twenty-four classes or divisions of the whole vegetable

kingdom, thus happily entwined by a N. Y. horticulturist, is an emblem of his absolute dominion over it.

"O Linnæus! the world in its successive revolutions every where can offer the ruins of cities, temples, pyramids, with those of prostrated columns, gorgeous palaces, and mausolea. But the sight of thy gardens is not done away—they are incessantly renewed with a greater luxuriance. May thy genius preside over us, and there always will be a bountiful soil for a plant, a fertile country for a nation, and a cultivated ground, with a hut for the poor."

N. B. A general meeting of the New-York Linnæan Branch will take place during the month of November next, of which due notification shall be given to distant or resident honorary and corresponding members. Communications may be directed to Samuel L. Mitchill, honorary president, or to Felix Pascalis, president, or to Elisur Mead, secretary.

New-York, Sept. 21, 1826.

3. *On the cutting of cast iron by soft iron.*—BENNINGTON IRON WORKS, Sept. 1, 1826.—Having recently been a little more at leisure, I have repeated the experiments mentioned in my letter of the 24th January last,* of cutting iron and steel by means of a revolving dix of plate iron, and am now convinced that the difference there noticed in the effect of the dix, was owing to the different degress of thickness of the substances subjected to trial; and that cast iron is as easily cut as either wrought iron or steel, if the plate be thin enough to be rapidly heated to ignition in the immediate line of contact with the disk. ISAAC DOOLITTLE.

4. *Correction by Gen.* MARTIN FIELD—*Extract of a letter addressed to the Editor, and dated* BELLOWS FALLS, June 5, 1826.—In the Journal of Science, &c. Vol. 6, p. 219, and Vol. 9, p. 55, it is erroneously stated, that *Pinite*, and *Rubelite* are found at Bellows Falls, Vermont. These errors have found their way into other publications; and the applications, from distant correspondents, for those minerals, have become very frequent.

The mineral, which occurs abundantly in the rocks about the falls, and particularly on the rocky island above the bridge, and on Fall Mountain, is unquestionably *Fibrolite*, which has been strangely mistaken for Pinite.

* Vol. X. p. 397 of this Journal.

In the granite rock, about half a mile below the falls, which contains the Prehnite, small crystals of red feldspar are found, which, in colour, bear some resemblance to Rubelite. These red crystals have, undoubtedly, been mistaken for the Rubelite. Tourmalines, of any kind, are rarely found in the rocks of that region.

5. *Collection of Minerals.*—A gentleman, long conversant in the collecting of minerals, and well acquainted with mineralogy, will put up, arrange and describe scientifically, a cabinet, of from two to four thousand specimens, of both foreign and American minerals. The specimens are stated to be fine, and to embrace a complete cabinet, including all the interesting localities of this country. The collection will be adapted to the views and interests of private individuals, or of public institutions, as may be desired. For terms and other information, reference may be made to the editor of this Journal.

6. *Double refraction.*—A correspondent remarks: "After a considerable number of experiments, with different transparent bodies, I find none which do not multiply objects, when cut and polished, with faces inclined to each other.—But, with the exception of Iceland spar, I have found no substance which exhibits double refraction, when the object is viewed through two opposite parallel faces. A notice of the experience of others in this respect, is requested."

Foreign Literature and Science—extracted and translated by J. Griscom.

1. Egypt. The vice-roy has founded a college at Boulah, in the palace which was inhabited by his son Ismael.—One hundred pupils, from nine to thirty-five years of age, are there maintained at his expense, and learn, under skilful masters, Chemistry, Mathematics, Drawing, Greek, Latin, Arabic, Turkish, Persian, and most of the languages of modern Europe. It appears that the higher employments of the administration are reserved for the young people who issue from this college.

The viceroy designs to plant, near Cairo, a botanic garden, which will be an adjunct to the school of medicine and surgery, which he intends to create, and which he has confided to the direction of European officers. A vast library, composed of the most remarkable books, in the different languages of Europe, on all the branches of medical science, is attached to this establishment. He has ordered, in London, an apparatus for gas illumination, for the use of his palace at Cairo, and the *place* in which it is situated.—*Revue Encyc. Jan.* 1826.

2. PRINTING. M. Senefelder, of Munich, *to whom* the arts are indebted for the invention of Lithography, *now so* extensively practised, with more or less advantage, throughout Europe, has just conceived a new kind of *stereotype*, which is accomplished as follows:—A sheet of common printing paper is covered with a suitable earthy mixture to the thickness of half a line, and which, after being properly moistened, acquires, in the course of half an hour, the consistency of paste. It is then placed upon the plateau of a common printing press, and the form of type, without being inked, is pressed upon it. This produces a mould, or engraving of the type. The leaf is then dried upon a stone, and melted metal poured upon it, by which a casting is obtained, in a thin plate, containing the characters, similar to the original type, in ample relief.—*Idem.*

3. SOOT. Henri Braconnot has analysed soot, obtained from the middle of a chimney in which nothing but wood was burned, and found it to consist of the following ingredients:

1. Ulmin, identical with that which is produced artificially by saw-dust and potash	30.20
2. Animalised matter, very soluble in water and insoluble in alcohol	20.00
3. Carbonate of lime, mingled with some traces of carbonate of magnesia	14.66
4. Water	12.50
5. Acetate of lime	5.65
6. Sulphate of lime	5.00
7. Acetate of potash	4.10
8. Carbonaceous matter, insoluble in alkalies	3.85
9. Phosphate of lime (ferruginous)	1.50
10. Silica	.95

11.	Acetate of magnesia	.53
12.	A particular acid and bitter principle, (asboline,) about	.50
13.	Chloride of potassium	.36
14.	Acetate of ammonia, estimated at	.20
15.	Acetate of iron, a trace	
	Total	100.00

The soot of a stove pipe gave nearly the same result. Among the essential products of soot are sulphuric and phosphoric acids, which appear to result from the combustion of sulphur and phosphorus contained in the wood. It is remarkable (says this chemist) that smoke can transport to such great heights the matters which I have determined in soot. We know that soot deposited in the chimnies of metallic founderies, sometimes contains the fixed metals, such as gold, silver, &c. I have discovered in soot very decided antiseptic properties, and have preserved animal substances in an infusion of it, during several months, without any alteration. Soot may be employed, also, for the purpose of obtaining a deep brown color of various shades, for paper hangings, by simply diluting with water a mixture of soot (in powder) and slaked lime.—*Ann. de Chimie. Jan.* 1826.

The contents of lampblack, agreeably to the same chemist, are the following:

Carbon	79.1
Water	8.0
Resin, analogous to that found in a fossil state in the vicinity of London, and examined by Thompson	5.3
Sulphate of ammonia	3.3
Asphaltum or bitumen	1.7
Sulphate of lime	.8
Silicious sand	.6
Ulmin, about	.5
Sulphate of potash	.4
Phosphate of lime, very ferruginous	.3
Chloride of potassium, a trace	
Total	100.0

Lampblack is a kind of soot, the carbonisation of which is much more advanced than that of common soot.

It may be concluded from the foregoing that all the soots contain essentially various sulphates. The presence of a notable quantity of sulphate of ammonia in lampblack, shows that it ought not (as is frequently done) to be employed in

the reduction of metals, when the object is to obtain them pure, and not in the condition of sulphurets.—*Ibid.*

4. NOTE *on the preparation and use of alkaline digestive pastils, containing bi-carbonate of soda; by* M. D'ARCET.—Having been obliged, three years ago, to make an almost daily use of pastils of magnesia, I was afraid that the frequent employment of this substance would contribute to favor the formation of urinary calculus, and I thought of substituting carbonate of soda. In 1822, I made a series of experiments, which gave me such good results that I decided, from that time, on taking no more magnesia for the correction of an impaired digestion, and from the month of September, in that year, I employed only pure carbonate of soda. These pastils instantly destroyed the acidity occasioned by bad digestion, and favored perfectly the functions of the stomach; but they had the inconvenience of being too strongly alkaline, and having a disagreeable taste. I nevertheless made use of them, with much success, until the middle of June, 1824, when I repaired, for the first time, to the waters of Vichy. I knew that these mineral waters were digestive, and I soon found that a glass, taken after a meal, was sufficient to promote digestion, and even to restore it when disturbed. Having verified the goodness of this remedy, during my first visit at Vichy, and knowing that the bicarbonate of soda is the active principle of these waters, and that this salt has a taste much less alkaline than that of carbonate of soda, I thought of substituting the former for the latter, in the pastils I made use of. I gave the receipt for these pastils to M. Regnauld, who began to offer them to the public in the month of January, 1825. The use of them having rapidly spread, and obtaining from them myself the best effects, I took the receipt to Vichy, in the month of June last. M. Batillar, apothecary of the thermal establishment, manufactured large quantities of them, and he now prepares, daily, five kilogrammes, or 5000 pastils. The receipt has been communicated to those who have asked for it, and the alkaline digestive pastils, prepared with bicarbonate of soda, are found in the shops of the first apothecaries of Paris, Lyons, &c.

The following is the receipt, as I have given it: I invite the apothecaries, who may avail themselves of it, to vary it as they may think proper.

Take bicarbonate of soda, dry and pure, in fine powder, 5 grammes. Very white sugar, in fine powder, 95 grammes Mucilage of gum adraganth,* prepared with water—q. s. essential oil of peppermint, pure and fresh, two or three drops.

The bicarbonate of soda and the sugar are to be put into a very dry bottle and thoroughly shaken, so as to mix the powders well together. They are then poured out and well mixed with the gum mucilage and oil of peppermint on a marble slab, and converted into pastils or drops, so that after being dried in the air, or by a stove, each may weigh about a gramme. Having a slight attraction for moisture, they should be preserved in bottles well stopped, or kept in a dry place.

Note by the translator.—By the advice of the discreet author of the above article, the carbonic acid disengaged from the fountains of Vichy, is employed in saturating the alkalies, and thus preparing, almost without expense, the bicarbonate of soda. Some of the best shops of Paris are now supplied with the bicarbonate from that quarter. The copious emission of gas from the waters of Balston and Saratoga might easily be employed for the same purpose and in all probability the alkaline pastils of D'Arcet be rendered as fashionable and useful there as at Vichy. But for the purpose of obtaining the alkali well charged with carbonic acid, a common brewer's vat or fermenting tub, might answer as good a purpose, and be used as cheaply as a natural spring. A solution of the common carbonate of soda, suspended in a broad vessel over the fermenting liquors, would doubtless become thoroughly charged with the gaseous acid. Frequent agitation would greatly expedite it.

It is further observed by M. D'Arcet, that a glass of the water of Vichy, (two decilitres,) contains 1 gramme of bicarbonate of soda, equal to the quantity contained in 20 of the pastils. The patients at Vichy commonly take 5 glasses of water every morning, besides a bath during the day in the same water. Supposing, (which is not the case,) that the water of the bath is not absorbed, it is certain that a drinker at Vichy, takes in a few hours as much bi-carb. of soda as if he had taken 100 pastils in the same time; but the experience of many ages has proved that the waters of Vichy are salutary to the health. The physician of the place, M. Lucas, has never known that those of his patients who have

* Tragacanth ?—Ed.

returned the most frequently have ever been troubled with diseases of the urinary passages; and it is proved, on the contrary, that the use of the waters re-establishes the digestive functions, and reproduces in the system, an energy which has surpassed all expectation.

These considerations are advanced to prove the *harmlessness* of using incidentally, alkaline remedies, not taken fasting, but when an acid disengaged in the stomach is ready to neutralise the small quantities of alkalie which the pastils contain.

Experience has shown that a feeble digestion may be easily remedied by taking only one or two of the pastils, and that it is seldom necessary to have recourse to a third, and that when the object is simply to facilitate the functions of the stomach, the pastils have many advantages over the water of Vichy, taken as it comes from the springs. Not only very painful indigestions, when they actually occur, may be remedied by these powders, but their occurrence may be prevented, by taking beforehand one or more of the pastils, and allowing the stomach to receive food, which, without this aid, would disturb its functions. The author states, that in his own case, the remedy has well established his digestive powers, and that he now seldom has recourse to the pastils, and can take, without their aid, food, which for two years past, he could scarcely have digested. In one instance which fell under his notice, a female, who had suffered for five hours, from a violent indigestion, was promptly relieved by taking a pastil every five minutes. The first she took afforded some relief, and eleven were sufficient completely to re-establish her digestion, although these eleven contained no more alkali than half a glass of the water of Vichy.

I will add, says M. D'Arcet, that in using these pastils, when one is fatigued with a slow and painful digestion, relief is more promptly obtained, than by employing pure or carbonated magnesia. The action they produce is so prompt and complete, that it appears purely chemical. He recommends the employment of them as soon as it is perceived that the stomach has become debilitated, for there is every advantage in adopting the remedy before the evil has become aggravated.—*Idem.*

5. Crystalline Substances from the Juice of Plants.—*Extract of a letter from* M. Baup *to the Editors of the "Annales de Chimie et de Physique."*—In the resin of the *pinus abies* L. I have found a new substance crystallizing in square plates, soluble in 7½ parts of alcohol, at 88 centiemes, and at 14 c., insoluble in water, &c. In the Colaphane of France, procured, from all appearance, from the *pinus maritima*, or *pinaster*, I have found another substance crystallizable in triangular plates, soluble in 4 parts of alcohol, equally insoluble in water, &c. These two new substances react, in the manner of acids; they combine as well with the alkalies as with the acids, and form real salts, some of which are soluble in water and alcohol, others only in ether. I have named the first *abietic acid*, and the second *pinic acid*. Both were presented, accompanied with a note, to our Society of Natural Sciences at Lausanne, on the 7th of December last.

I had previously found and presented to the same Society, in July, a new substance from the resin of the *arbol a brea*, (a tree, not well determined, of the Island of Manilla,) crystallized in very brilliant rhomboidal prisms, soluble in about 70 parts of water, terminated on each side by a basil, completely insoluble in water. This I named, provisionally, *breine*. Finally, another in the resin of the Amyris elemifera, L. This has a near relation to the preceding, but differs in its greater solubility in alcohol, by its crystalline form, &c. It is *elemine*.

In examining the properties of potatoes, I met with solanine; this substance, which M. Desfosses discovered some years ago in two congenerous plants, the bitter-sweet and the night shade, will therefore be added to the other products of the analysis which have been made of this solanum. The tubercules contain much less of them than the germs, which have also a very acrid taste. I have no doubt that soon or late, advantage will be taken of it in medicine, and thus a new service will be rendered by this plant, already so valuable to man.—*Ibid.*

6. *The Butterfly collector's Vade Mecum.*—This work in 12mo. with coloured plates, price 5s. W. B. Whittaker, London, contains a synoptic table of English butterflies, with instructions for collecting and preserving them; an indication of the particular character of the eggs, the caterpillars

and crysalides of each species, and a detailed description of each butterfly.

7. *Process for charging water with iron.*—If we form a pile with a few pieces of silver and iron plates, placed alternately, and immerse this pile in water, the fluid will soon acquire a yellowish tint, and in 24 hours the oxide of iron will appear in abundance. If the ferruginated water be withdrawn, and the vessel be filled every day with fresh water, we shall have a kind of artificial mineral spring.*—*Payen. Bul. Un.* 1824.

8. *Reduction of sulphurous acid.*—M. Dobereiner observed that alcohol, saturated with sulphurous acid, dissolved more iodine, than if it were pure. The liquid containing these two substances, exposed to the rays of the sun, deposited, to his great astonishment, crystals of sulphur.—*Bul. Un. Sep.* 1824.

9. *Russian Drinks.*—The common drinks in Russia are the *Kwass*, and the *Meth* or *Kisslichi*. To prepare the *Kwass*, they take a quantity of rye, and having soaked about a tenth part of it, they spread it thinly on boards or plates, and expose it to moderate heat, until it sprouts, taking care to sprinkle it now and then with warm water.. When sufficiently germinated, they mix it with the rest of the rye, previously ground, and add to the mass a quantity of warm or tepid water. The vessel is then put into an oven, immediately after the bread is drawn, or exposed to a similar temperature, and by degrees more water is added to the paste, stirring it on every addition. After a time of repose, and when the liquid has become a little clean, it is put into a keg or barrel, in which it ferments during several days. It is then put into the cellar, and in a few days is drinkable. This beverage is better when, instead of putting it into casks, it is

* At page 105, vol. VIII. of this Journal, is the following notice by Professor Hare :—" If a few pieces of silver coin be alternated with pieces of sheet iron, on placing the pile in water, it soon acquires a chalybeate taste and a yellow hue, and in 24 hours, flocks of oxide and of iron appear. Hence, by replenishing with water a vessel, in which such a pile is placed, after each draught, we may have a competent substitute for a chalybeate spring. Clean copper plates, alternating with iron, would answer; or a clean copper wire entwined on an iron rod ; but as the copper, when oxidated, yields an oxide, it is safer to employ silver. As Dr. Hare's observation was published early in 1824, we are bound to regard it as original with him—Ed.

fermented in large jugs, and when clarified, put into bottles. It then acquires a vinous taste, lively and agreeable, and is of a yellowish color. The sediment is good for cattle.

The *Kisslichi* is thus prepared. R. 2 lbs. of rye malt, and the same quantity of barley malt; make a paste of them with warm water, and let it ferment till it has acquired a strong taste. Dilute it with 10 lbs. of tepid water, and add a few lemon peels. When fermenting, add 20 lbs. of water, and after the fermentation is complete, bottle it.

The *Bartsch*, which is drunk principally in Poland and Lithuania, is made with the young leaves and seeds of the acanthus, boiled in water, to which leaven is added, and after fermentation and filtering, it is kept in a cool place.

Bul. Un. Jan. 1825.

10. *Experiments to aid in the history of muriatic (hydrochloric) acid;* by MACAIRE and AUG. DE LA RIVE.—The experiments which these authors presented to the Society of Physics and Natural History of Geneva, on the 19th of June, 1823, may be arranged under two heads. Those which relate to the action of certain combustibles upon the combinations called *chlorides;* and those which relate to the action of the pile upon muriatic acid, (hydrochloric,) and upon chlorine.

Experiment 1.—Melted chloride of silver was treated at a very strong heat with boron, without undergoing any decomposition. Now as chlorine is volatile, and boruret of silver is fixed, it would seem that action ought to have taken place, if chloride of silver is a combination of a metal with a simple substance.

Exper. 2.—After having introduced into a porcelain tube, some melted chloride of silver, a current of hydrogen gas, thoroughly dried by chloride of calcium, was passed through it. The apparatus was adjusted so as to receive the liquid and gaseous products. The passage of hydrogen was continued a long time without perceiving any trace of humidity; but as soon as heat was applied to the part of the tube which contained the chloride of silver, abundant fumes of muriatic acid escaped, water was deposited in the receiver, and the chloride of silver was reduced to the metallic state. The absence of common air in the apparatus, obliges us to ascribe to the chloride of silver, the oxygen which formed this water. The same experiment made with chloride of lead, did not de-

posit water in the receiver, but it was filled with dense fumes of muriatic acid, which announce the presence of water.

Exper. 3.—In treating chloride of sulphur, cold, with potassium in a bent tube under mercury, muriatic acid gas was obtained, and the residuum appeared to contain chloride of potassium, (muriate of potash,) and sulphate of potash, mingled with uncombined sulphur. Now, if, as the authors remark, chloride of sulphur is composed of nothing but sulphur and chlorine, and the latter is regarded as a simple substance, how can muriatic acid and sulphate of potash be formed by the action of potassium alone?

Exper. 4.—Proto-chloride of mercury, treated with heat, with potassium, in a bent and well luted tube, produced a disengagement of gas, which was ascertained to be azote. The residuum consisted of chloride of potassium and metallic mercury. Chloride of silver treated in the same manner, or strongly heated with metallic zinc, gave the same results. These experiments made with potassium, occasioned frequent rupture of the tubes, with explosion, by which one of the two operators was seriously injured.

Exper. 6.—In decomposing corrosive sublimate (deuto-chloride of mercury) in a tube of iron, filled with turnings of the same metal, and strongly heated, there was also a liberation of azotic gas. The interior of the tube exhibited, after the operation, many globules of mercury, and an abundant quantity of chloride of iron. Neither of the two existing theories can account for the production of this gas.

Exper. 9.—Liquid muriatic acid (hydrochloric) exposed to the action of the voltaic current, gave, at the negative pole, a great quantity of hydrogen, and at the positive pole no gas was disengaged. In admitting, as is the case in the decomposition of all the acids by the pile, the simultaneous decomposition of water, we cannot, according to the views of Messrs. Macaire and De La Rive, explain the absence of oxygen in this case, except by admitting its combination with muriatic acid to form chlorine, which remains dissolved in the water.

Exper. 10.—A concentrated and recent solution of chlorine in water, exposed to the current of the pile, gave a great quantity of oxygen at the positive pole, and very little hydrogen at the negative Was the chlorine resolved into oxygen which showed itself at the positive pole, and muriatic acid which remained in solution? or, did the hydrogen of the de-

composed water, combine in its nascent state, with the chlorine, to form muriatic acid? But then the authors ask, why this residuum of hydrogen at the negative, and so great a quantity of oxygen at the positive pole?

In completing the very detailed enumeration of these experiments, M. M. Macaire and De La Rive think it right again to remark, 1st, that several of them appear to indicate the presence of oxygen in the compounds called chlorides. 2d, that the experiments which show the presence of oxygen in chlorides, as well as those which relate to the action of the pile upon muriatic acid and upon chlorine, seem to be more easily explicable on the theory which regards chlorine as a compound body. 3d. Finally, that a part of the experiments relative to the production of a gas similar to azote, obtained by treating the metallic chlorides by a combustible, cannot find a place in any of the theories hitherto advanced.

J. J. LASSAIGNE—*Bul. Un. Feb.* 1825.

11. *Disappearance of the breasts caused by the employment of* IODINE.—Much has been said of the good effects of Iodine, in swellings of the thyroid gland, and against scrofulous tumours in general; but no where has the fatal action which it exercises on the breasts been properly noticed. M. Hufeland reports, among other cases, that of a girl twenty years of age, endowed with a good constitution, who made use, during six months, of the tincture of Iodine, for the resolution of a goitre. It produced the desired effect: but she perceived in time that her breasts were sunk, and diminished in volume. Notwithstanding the disuse of the Iodine, this diminution continued, so that at the end of two years there remained no vestige of the mamillary gland. Two other analogous cases might have been cited, but the preceding, M. Hufeland thinks sufficient to arrest the attention of practitioners upon a subject of so much importance, for if these facts are confirmed, in a majority of cases, a remedy which deprives a female of one of her most important organs, ought to be rejected.

The author asks, in conclusion, if it is not possible that this particular action of Iodine upon the sexual organs may not extend itself to the testicles and ovaries. Besides, he observes, the extraordinary effect of this remedy upon these organs in the normal state, might be efficacious in a pathological condition.

We shall add, that the employment of Iodine, externally, produces the same alterations. M. Eusebe de Salle has successfully employed iodine in a chronic enlargement of the testicles, and Magendie, in his formulæ, under the article Iodine, has made known the results of this medicament.

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12. *Sugar from Beets.*—Although the cane sugar, with the exception of the duties which it pays on admission into France, is much cheaper than it has been for a long time in Europe, it is still advantageous to manufacture sugar from beets. Hitherto the production of beet sugar among us has been solely confined to capitalists;—but these are not often the persons who are willing to confine themselves in a manufactory, superintend its operations, and dispose of its products. To promote as much as possible the production of sugar from beets, a writer in the French annals of agriculture proposes to form an association among cultivators, analogous to those in Switzerland and in the Jura, among the owners of cows for the fabrication of Gruyere cheese; that is to say, that the cultivators should send their beets to a manufactory established by a joint stock, at the head of which should be an expert chemist, and that the sugar thus manufactured, should, after paying expenses, be distributed, *pro rata*, among those who furnished the beets. I have no doubt that such an association would be advantageous to the stockholders, but it would be difficult to form such a company in France, the farmers being generally disinclined to this mode of turning to profit the produce of their land.—Bosc.—*Idem.*

13. Treatise on the Theory and Practice of Vinification, *or the art of making Wine, with all kinds of fermentable substances, at all times and seasons*; by L. F. D. author of the art of making beer. 12mo. p. 408, with a plate. Paris, 1824.

The previous work of the author, excited the hope that the present would be useful to the progress of the art of wine making, and this hope has not been disappointed. It is divided into *three parts.* The first treats of substances suitable for making wine, of the saccharine principle, of fermentation, effects of temperature, action of the air, the influence of the *must* upon this fermentation, and the various phenomena connected with the fermentation, such as heat, carbonic acid, alcohol, colour &c.

The second part is entitled the *practice* of the art of wine making, and embraces the various circumstances connected with, season, maturity of fruit, richness in sugar, of making wine from raisins (dry,) cherries, gooseberries, elderberries, mulberries, quinces, oranges, plumbs, potatoes; of cider, perry, and beer. The third part relates to factitious or imitative wines and other liquors. However perfect and wholesome these may be, is it loyal to favour the practice, since it facilitates fraud, either with respect to individuals, or government?

The third part is not inferior to the preceding, and it will be read, even after the excellent work of M. Jullien, entitled *Manuel de Sommelier*, (the Butler's Manual.) It treats of the management of wine in cellars, the racking, clarification, mixture, alterations, &c.

The author devotes a section to the products of wine, viz. the dregs, tartar, alcohol and vinegar, and finishes with particulars respecting the knowledge, tasting and analysis of wine. The work of Z. F. D. contains almost all the information necessary for deriving the greatest advantage from vineyards, and must be eminently useful.—Bosc.—*Idem.*

14. *Nourishment of Horses.*—The practice is becoming general in Silesia, of feeding horses with *bread.* After an experience of 4 years, an intelligent husbandman is convinced of its utility in the double relation of economy and health. The bread is made by taking equal quantities of oat meal and rye meal, mixing it with leaven or yeast, and adding one third of the quantity of boiled potatoes. To each horse is given 12 lbs. per day, in three rations of 4 lbs. each. The bread is cut into small pieces, and mixed with a little moistened cut straw. By this means, he saves in feeding seven horses, 49 bushels of oats in 24 days; while the horses perform their common labour, and are much better in looks, health and disposition.—*Idem.*

15. *Preserving Skins.*—I. Steger, a tanner at Tyman, in Hungary, uses with great advantage, the pyroligneous acid* in preserving skins from putrefaction, and in recovering them when attacked. They are deprived of none of their useful qualities by covering them, by means of a brush, with the acid, which they absorb very readily.—*Ibid.*

* The friends of Dr. H. H. Hayden, of Baltimore, know that he made this application several years ago.—Ed.

16. *Natural History of the Grub, or Vine-fretter.* (Puceron.)—The 25th of May, 1809, M. Duvau placed under a glass with food, a bean grub, (puceron de la fève) which he had just taken at the moment of its issuing from the body of its mother. On the 10th of June following, this grub produced a young one; it was isolated; the grub which it produced was isolated in its turn, and so on to the *eleventh* generation, which took place on the 25th of December, and whose issue died on the 27th without posterity.

Sometimes winged pucerons produce pucerons without wings, and sometimes the latter produce those with wings.

The observations of M. Duvau agree with the results of previous enquirers. Some experiments of Leuwenhoeck, made about the commencement of the last century, indicate that pucerons may multiply without coupling. This curious fact was confirmed in 1740, by the nice experiments of Bonnet. Réamur and Degur showed, two years afterwards, that it is possible to obtain ten generations successively of pucerons, kept isolated under glasses. M. Duvau has of course obtained one generation more than Réamur.—*Annales de Chim. et de Phys. Jan.* 1825.

APPENDIX.

Correction of an oversight in Lagrange's formulæ for determining the motions of any system of bodies immediately about a state of equilibrium, by H. J. A.*

It appears to the writer of this, that Lagrange, in copying out for the press, the formulæ which he has given at page 351, vol I. of the Mécanique Analytique, for determining the stability of *equilibria*, and the laws of the small oscillations of any system of bodies, has inadvertently omitted certain terms which are essentially necessary to the correctness of the results. The quantities there denoted by the characters [1], [2], [3], [1,2], &c. are the coefficients of the terms containing two dimensions of the independent variables in the general value of V, which is formed by developing, according to the powers of the increments of the three original co-ordinates, the algebraic function Π, giving to these co-or-

* Received too late for insertion in its proper place.—Ed.

dinates their values in the state of *equilibrium*, substituting for their increments equivalent quadratic functions of small independent variables, and then integrating with respect to the dimensions of the system. In doing this, it is evident, that in order that nothing may be neglected which may affect the terms of two dimensions of ξ, ψ, φ, &c. in the value of V, (the only terms in that function which it is necessary to attend to,) the terms of the second dimension which enter into the value of the increments of the co-ordinates, must be included in the multiplication by all the *first* differential coefficients in the developement of F, although they may be disregarded in the substitutions for the powers and products of the increments of the co-ordinates. It will then easily be seen, that to render the co-efficients [1], [2], &c. complete, it will be necessary to add to them the following integrals:

$$\text{To } [1] \qquad 2S\left(\frac{dF}{da}a'1+\frac{dF}{db}b'1+\frac{dF}{dc}c'1\right)\mathrm{m}$$

$$[2] \qquad 2S\left(\frac{dF}{da}a'2+\frac{dF}{db}b'2+\frac{dF}{dc}c'2\right)\mathrm{m}$$

$$[3] \qquad 2S\left(\frac{dF}{da}a'2+\frac{dF}{db}b'3+\frac{dF}{dc}c'3\right)\mathrm{m}$$

&c. &c.

$$\text{To } [1,2] \qquad S\left(\frac{dF}{da}a1,2+\frac{dF}{db}b1,2+\frac{dF}{dc}c1,2\right)\mathrm{m}$$

$$[1,3] \qquad S\left(\frac{dF}{da}a1,3+\frac{dF}{db}b1,3+\frac{dF}{dc}c1,3\right)\mathrm{m}$$

$$[2,3] \qquad S\left(\frac{dF}{da}a2,3+\frac{dF}{db}b2,3+\frac{dF}{dc}c2,3\right)\mathrm{m}$$

where $a'1$, $a'2$, $a'3$, &c. $a1,2$, $a1,3$, $a2,3$, &c. are the co-efficients respectively of ξ^2, ψ^2, φ^2, &c. $\xi\psi$, $\xi\varphi$, $\psi\varphi$, &c. in the general value of x; $b'1$, &c. of ξ^2, &c. in the general value of y; $c'1$, &c. of ξ^2, &c. in the general value of z. (p. 349.)

The value of T, which is half the sum of the living forces of the system, is evidently, in the case of small oscillations, unaffected by the above omission.

The corrections in the foregoing formulæ, are, no doubt, such as every practised mathematician who has carefully read this chapter of the Mécanique Analytique, has already made for himself; but as the error is, at all events, to be found in the last edition of the first volume, that of 1811, and as the formulæ in question afford by far the simplest, the most

general and the most compendious method known for determining the laws of all the small oscillations, single or coexisting, of every possible system of bodies, it was thought that a few words of explanation in some public journal, might have the effect of preventing the embarrassment which a student of Lagrange would experience in applying them, without previous verification, to such cases, and they are many, as are affected by the omission.

While on this subject, it may be as well to add, that in practice it will frequently be possible, and when possible, very convenient, to convert the function Π, into an explicit function of the quantities of which ξ, ψ, φ, &c. are the small increments. If Π remain a direct function of the three rectangular co-ordinates, it will not be sufficient to express the increments of these co-ordinates in linear functions of the small independent variables. These functions must be quadratic, or the value of V will be incomplete, and the result will be erroneous. But if Π be transformed in the manner above alluded to, the co-efficients of the terms of two dimensions in the values of x, y, z, affect no part of the calculation, and the similar co-efficients in the integral $S\Pi m$ or $S\Pi Dm$, will be given immediately without substitution, each of them by the integration of a single differential co-efficient, multiplied by m or Dm, as the circumstances of the system may happen to require.

INDEX TO VOLUME XI.

Errata.—Vol. XI.

P. 5, line 16 from bottom, for *make* read *makes.*
P. 16, line 13 from bottom, for *directed* read *direction.*
P. 42, bottom line, for *lunguage* read *language.*
P. 65, line 9 from bottom, for *makingt o* read *making to.*
P. 160, line 20 from top, for *fllacca* read *flacca.*
" line 4 from bottom, for *subcylindra ceis* read *subcylindraceis.*
" line 3 from bottom, for *fredunculata* read *pedunculata.*
" line 2 from bottom, for *subloxifloris* read *sublaxifloris.*
" line 4 from bottom, and bottom line, for *stameniferis* read *staminiferis.*
P. 243, line 16 from bottom, for *movements* read *increments.*
P. 244, line 7 from top, for *dependant* read *dependent.*
P. 245, $y=a^{\frac{1}{2}} \propto^{\frac{1}{2}} \propto x^{\frac{1}{2}}$, should be $y=a^{\frac{1}{2}} x^{\frac{1}{2}} \propto x^{\frac{1}{2}}$, and $y \propto x^{\cdot\frac{1}{2}}$.
P. 246, line 5 from top, for *De Lambert* read *D'Alembert.*
P. 384, line 22 from top, for *dix* read *disk.*
In a part of the edition, p. 259, line 10 from top, for *due* read *two*, and expunge the note at bottom.
P. 384, line 17 from bottom, for *Elizur* read *Elijah.*

Ta

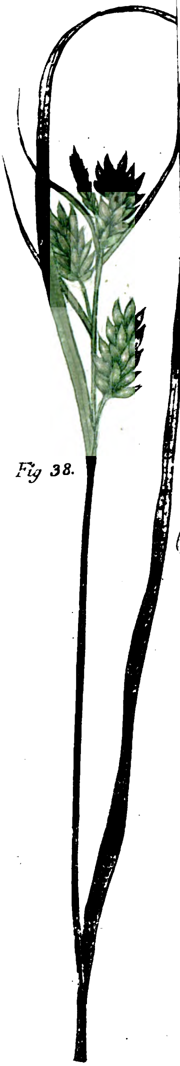

Fig 38.

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Fig. 42.

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C. turbinata.
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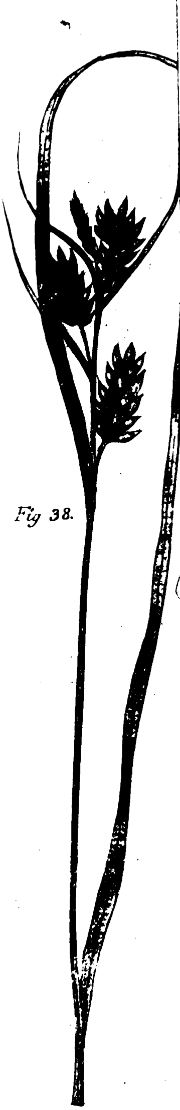

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